LOWER GREEN RIVER LEVEE AND REVETMENT REPAIRS

Construction Years 2001-2003
Batched Biological Assessment for
Puget Sound Chinook and Coho Salmon,
Bull Trout and Bald Eagle

Second Draft Report Prepared by
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February, 2001

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1 INTRODUCTION

The purpose of this biological assessment (BA) is to review the effects of seven proposed levee and revetment repair projects (summarized in Table 1.1) on stocks of lower Green River chinook and coho salmon, bull trout, and bald eagles. This BA was prepared in accordance with section 7(c) of the Endangered Species Act (ESA) of 1973 to determine whether federally listed or proposed threatened or endangered species and/or candidate species in the project vicinity could be affected by construction of these projects. The project proponent, the King County Rivers Section, would like to assist the U.S. Army Corps of Engineers (USACE), the federal action agency, in conducting formal consultation with the National Marine Fisheries Service (NMFS) and the U.S. Fish and Wildlife Service (USFWS) at the earliest possible opportunity.

Table 1.1 Summary of Proposed Construction Years 2001-2003 Lower Green River Levee and Revetment Repairs

CONSTRUCTION YEARS 2001-2003 LOWER GREEN RIVER LEVEE AND REVETMENT REPAIRS						
						LWD
						PIECES
FACILITY	**FACILITY**	**LOCATION**		**LINEAL**	**BENCHED**	**TO BE**
NAME	**TYPE**	**(RM)**	**BANK**	**FEET**	**SLOPE**	**INSTALLED**
Segale	Levee	15.4	L	190	No	20
Desimone	Levee	15.4-15.6	R	1,300	Yes	63
Boeing	Levee	17.8	R	130	Yes	16
Frager Road	Revetment	18.5	L	175	No	40
Narita	levee	21.2	R	550	Yes	59
Pipeline	hybrid	21.9	R	500	Yes	33
Fenster	hybrid	32.0	L	220	Partial	46
			Total	3,065		277

If approved, these projects will be carried out by Green River Flood Control Zone District (GRFCZD), a quasi-municipal corporation of the State of Washington authorized by RCW 86.15. This state law establishes that the King County Council will serve as the Board of Supervisors for the GRFCZD, and grants the GRFCZD all the authority for flood hazard reduction elsewhere granted to counties. The GRFCZD is authorized to raise revenues by taxes levied against the assessed value of properties within its boundaries, and to accept revenues from other sources in order to accomplish its public purpose of flood hazard reduction. The GRFCZD was originally established with concurrence of all affected lower Green River municipalities--the Cities of Tukwila, Renton, Kent and Auburn--in 1960. Early activities were limited to sponsorship of federal flood control improvements affecting tributaries to the Green River, such as construction of the pump stations serving the Springbrook Creek and Southcenter drainages, and channel relocations affecting Mill Creek in Auburn. This changed in 1990 with activation of the GRFCZD's taxing authority through interlocal agreements with the cities for the purpose of maintaining and repairing the levees and revetments located within the GRFCZD boundaries. These extend from the SR-99 bridge (river mile (RM) 6.50) in Tukwila to SR-18 (RM 33.85) upstream from Auburn (see Appendix A). Projects constructed within the GRFCZD are permitted under applicable federal, state and municipal regulations, with the King County Water and Land Resources Division (WLRD) Rivers Section as the permitee.

1.1 Rationale for Batched Biological Assessment

Section 7(a) of the ESA, as amended (16 U.S.C. 1531 et seq.) requires federal agencies to conserve endangered and threatened species. Section 8(a)(2) requires consultations to ensure that any action authorized, funded or carried out by a federal agency is not likely to jeopardize the continued existence of listed, proposed or candidate species or result in the destruction or adverse modification of critical habitat for such species. This includes actions by the Federal Emergency Management Agency (FEMA), which funds repairs to flood damaged facilities; the U.S. Department of Housing and Urban Development (HUD), which funds community development block grants that may be applied to the modification of flood control facilities; and the USACE, which permits flood control facility repairs in waters of the United States under its Clean Water Act Section (CWA) 404 permit program. Section 7(c) of the ESA requires that a BA be prepared for major construction projects if any of those species or their critical habitats are present in the proposed action area of such projects.

The NMFS encourages evaluators to conference/consult at the watershed scale (i.e., on all proposed actions in a particular watershed) rather than on individual projects (NMFS 1996). While it is beyond the ability of the staff of the King County Rivers Section to conference/consult on all actions that could occur between 2001 and 2003 in the Green/Duwamish River watershed, this batched BA is our response to NMFS' preferred approach for adequately analyzing the potential effects of seven proposed King County River Section flood control facility repair projects along the lower Green River during a series of summer construction seasons between 2001 and 2003, in accordance with requirements of Section 7 of the ESA. This approach to grouping a set of projects is being taken because:

- All of these facilities are located in reaches with similar geomorphic characteristics, namely low gradient alluvial reaches lacking in channel complexity and prone to toe erosion and saturation slumping.

- All of these facilities are located within the same 15 mile segment of the lower Green River; thus their repair will potentially affect the same suite of ESA listed species.

- All of these facilities have oversteepened, riprap-lined banks, are devoid of canopy cover and are vegetated primarily with invasive plant species.

- All of these facilities will be repaired using similar bioengineering methods including large toe rock, large coniferous logs with rootwads and extensive revegetation with native riparian species. The project designs incorporate the maximum amount of facility setback (and in one case removal of the upstream end of a facility) possible, given budgetary and physical site constraints in order to achieve habitat restoration and flood hazard reduction.

- Construction of these projects is proposed to be carried out within during the same eight week summer construction window during a series of construction seasons between 2001 and 2003.

If the federal agencies approve of this batched approach, King County Rivers Section staff would like to update this BA periodically to address Section 7 consultation requirements on additional batches of similar flood control facility repairs in the future.

It is hoped that Section 7 review for proposed actions at all seven of these project sites can be addressed in single consultations between the USACE (the action agency by virtue of its issuance of Section 404 Nationwide Permit #3 for these projects), and NMFS and USFWS, respectively

1.2 Biological Assessment Objectives

The objectives of this BA are to assess and evaluate:

- the level of use of the action area by the listed, proposed and candidate species,
- the effects of proposed actions on the listed, proposed and candidate species' primary food stocks, prey species, and foraging areas,
- the impacts from the proposed actions that may result in disturbance to listed, proposed and candidate species, including their avoidance of the project sites.

This BA begins with an overview of conditions that are common to all seven projects, and a discussion of the status of listed, proposed and candidate species known or thought to exist within the action areas. Each project is then discussed individually in a separate chapter of the report covering the project location; site specific conditions; a detailed description of the proposed action, purpose and need; the sequence of construction activities (including measures to avoid and minimize adverse impacts on listed, proposed and candidate species), and the construction schedule. The BA concludes with a discussion of the effects of the actions, conservation measures, the issue of incidental take, and the determination of effects of the actions on listed, proposed and candidate species within the action area. Project plan drawings and photographs are contained in appendices to the report.

1.3 Proposed Actions

The Rivers Section of the King County Department of Natural Resources WLRD proposes to repair seven existing, flood damaged levees and revetments and improve salmonid and riparian habitat along the lower Green River within the GRFCZD, a reach of the Green River between RM 6.50 and 33.85 within the Cities of Tukwila, Kent and Auburn and unincorporated King County, Washington. Activities at six of these sites will include stabilization of eroding and/or slumping streambanks, removal of invasive exotic vegetation, installation of large woody debris (LWD) and revegetation with native riparian trees and shrubs. At the seventh site (Fenster Revetment Repair), a flood damaged revetment culvert that poses a partial barrier to salmonid fish passage will be removed along with a short segment of the downstream end of the revetment.

These seven proposed projects constitute a small portion of a current backlog of approximately 15,000 linear feet of as yet unrepaired flood damages along GRFCZD facilities. Over the past nine years, a total of approximately 14,000 linear feet of facility repairs have been accomplished, averaging about 1,500 linear feet per year. Repairs are typically scheduled each year in order of priority ranking. It is proposed that the group of repair included in this BA (those that rank the highest on the current priority ranking list) be constructed over a three year period, starting in 2001. Based on past experience, the durability of repairs accomplished to date indicates that it is highly unlikely these sites will require significant amounts of additional repair work anytime soon. Instead, their structural stability will likely increase over time, for the following reasons: (1) as the planted native vegetation matures, it produces deeper, more secure rooting systems which bind the facility soils; (2) as willow growth becomes increasingly dense along the lower bank it reduces near-bank water velocities, which in turn reduces toe erosion and induces sediment deposition onto the bankline, which stimulates further native plant growth; and (3) installed LWD deflects erosive flows away from the facility toe, thus increasing bank stability. In the case of three of these proposed repairs that include resloping the existing facility to gentler angles of repose, it is anticipated that slumping and erosion will decrease because of increased stability of the new slope angles.

Occasionally minor repairs are needed at facilities which have been previously repaired using bioengineering techniques such as those described in this BA. For example, minor repositioning of several LWD installations was needed at the Russell Road Lower Revetment in 1999, where some of the logs installed parallel to the bank in 1998 had become suspended on the midslope of the facility, and others were “fish-tailing” out in the channel. This work was done using a combination of hand crews who “lassoed” the errant logs using cables, which were then attached to a trackhoe mounted on previously constructed benches several feet above the ordinary high water mark (OHWM). After cinching the logs back into their design configuration using the cables, the chains previously used to attach the logs to log flow deflectors embedded in the bank were tightened to secure the logs back into the desired orientation parallel to the bankline.

The currently proposed Segale Levee Repair represents another example of a minor repair of a previous bioengineered repair. Here, even though the slopes above the OHWM show no signs of deterioration, and in fact continue to support growing stands of planted willows, the outermost facing of toe rock has been dislocated due to undercutting of the shifting sand and silt deposits along the channel margins at this location. If not repaired, there is a potential for continued toe deterioration, leading to undermining and failure of the affected portion of the facility, including the previously planted bankline. Compared to the initial repairs undertaken in 1996 at this site, the scope of work involved in currently proposed repair is fairly minor. Because this localized work will involve the installation of additional LWD in an array intended to further stabilize the streambank below the OHWM, it is in some respects rather similar to the LWD repositioning described above.

All in all, future repairs at any of the seven sites covered in this BA are likely to be relatively minor, "touchup" corrections to initial repairs. The bulk of all future GRFCZD repairs are much more likely to be performed at other facility site locations for which future BAs will be prepared for Section 7 review.

1.4 Green River Action and Project Areas

For purposes of this BA, the listed, proposed and candidate species **action areas**, shown in Figure 1.1, for affected species are defined as the riverine and associated riparian habitats supporting ESA listed, proposed and candidate fish and wildlife species that could be affected directly or indirectly by the proposed projects.

Specifically, the **chinook and bull trout action area** is defined as the entire channel of the Green River from RM 14.4 (one mile downstream from the Segale Levee Repair site) to RM 33.0 (one mile upstream from the Fenster Revetment Repair site) that would be likely to harbor fish that leave the project site reaches due to construction impacts, plus the adjacent riparian area 100 feet landward from the OHWM at each project site that will potentially be disturbed by construction impacts. This one mile upstream distance was selected because, based on a study of the potential effects of pile driving activities on the behavior and distributions of juvenile pink and chum salmon, it represents an approximate doubling of the estimation by Feist (1991) of the distance from the project reach in which juvenile chum salmon behavior, distribution and/or general ecology might be affected by alterations in the acoustic environment by heavy equipment operation during construction activities in an estuarine environment. The one mile downstream distance was selected because it greatly exceeds the maximum distance of any sediment plume ever observed by Rivers Section staff to have emanated from any of the 26 GRFCZD facility repairs conducted during the 1990s (Andy Levesque, King County, pers. com. 1999).

The **bald eagle action area** is defined as the area 1,000 feet landward of the OHWM from RM 15.1 to RM 33.4 that may used by bald eagle eagles along the lower Green River. The presence of bald eagle nests within the bald eagle action area would indicate the possible need to provide substantial protection from disturbing activities in the form of buffers up to 2,600 feet in width (Anthony and Isaacs 1989) adjacent to these project sites. However, construction of these projects is proposed to occur well after the time that fledglings leave the nest, and well before nest building activities commence in the fall. Eagles are less subject to disturbance outside of the nesting season, as evidenced by the work of Stalmaster and Newman (1978), who found that 98 percent of eagles foraging in open areas tolerated human activities at 1,000 feet. Therefore, this latter distance was selected as the bald eagle action area boundary around the river reach in which the projects are located.

The seven **chinook, coho and bull trout project areas**; shown in Figures 3.1, 4.1, 5.1, 6.1, 7.1, 8.1 and 9.1, and described in Chapters 3 through 9; are defined as the seven sites where construction activities will occur, plus immediately adjacent areas 2,000 feet upstream and downstream that could support listed, proposed or candidate species, and within which chinook and coho salmon and bull trout abundance, behavior, distribution and/or general ecology might be affected by alterations in the instream acoustic environment by heavy equipment operation during construction activities (Feist 1991).

The seven **bald eagle project areas,** shown in Figures 3.1, 4.1, 5.1, 6.1, 7.1, 8.1 and 9.1, and described in Chapters 3 through 9; are defined those within 1,000 feet of each project site, within which it was judged that bald eagles might be disturbed by construction activities (Stalmaster and Newman 1978).

Both fish and bald eagle **action areas** are subject to similar regulations and guidelines and exhibit roughly similar fish and wildlife populations. Therefore, common project elements are discussed together in the following chapter of this document. Applicable regulations with which these projects will comply, and background information reviewed during preparation of this BA are listed in Appendix B.

1.5 Listed, Proposed and Candidate Species

Fish

Information about ESA listings for salmon, steelhead and cutthroat trout (*Oncorhynchus*) stocks was taken from NMFS' website (http://www.nwr.noaa.gov/1salmon/salmesa/pubs/1pgr.pdf) on January 3, 2001. Comparable information for bull trout (*Salvelinus confluentus*) was taken from the USFWS' website (http://ecos.fws.gov/species profile/species profile.html?spcode=E065) on January 3, 2001. Chinook salmon range in the action area and are currently listed as a threatened species under the ESA. Coho salmon (*O. kisutch*) may also range in the action area year around and are currently a candidate species eligible for listing under the ESA. Bull trout may also occur in the action area and are listed as a threatened species under the ESA.

Wildlife

Bald eagles (*Haliaeetus leucocephalus*) range in the action area and have long been listed as a threatened species under the ESA. Information about the current proposal by USFWS to remove the bald eagle from the federal list of threatened wildlife was taken from rules promulgated at 50 CFR Part 17 published in the Federal Register on July 6, 1999. Information about their status as a Washington State listed species was taken from Washington Department of Fish and Wildlife's website (http://www.wa.gov/wdfw/wlm/research/raptor/eagle/eagle.htm) on May 2, 2000 (see Appendix B), and from WDFW's priority species database.

1.6 Summary of Findings

Table 1.2 Summary of Listed, Proposed, and Candidate Species Present in the Lower Green River Action Areas

SPECIES	FEDERAL STATUS	STATUS IN BASIN	STATUS IN ACTION AREA	PROJECT EFFECTS
Chinook Salmon (*Oncorhynchus tshawytscha*)	Threatened.	Present.	Adult chinook salmon are known to migrate upstream within all seven sites within the action area, and spawn in the vicinity of one site, Fenster Revetment Repair; juvenile rearing and downstream migration also occur throughout the action area.	May affect, likely to adversely affect (LAA).
Coho Salmon (*Oncorhynchus kisutch*)	Candidate.	Present.	Adult coho salmon are known to migrate upstream within all seven sites within the action area, and spawn in the vicinity of one site, Fenster Revetment Repair; juvenile rearing and downstream migration also occur throughout the action area.	An effect determination is not being made at this time. If proposed, may affect, likely to adversely affect. If listed, may affect, likely to adversely affect (LAA).
Bull Trout (*Salvelinus confluentus*)	Threatened.	Presumed present.	No spawning habitat present. Adults may migrate upstream and downstream within the action area; juveniles may migrate downstream within the action area.	May affect, likely to adversely affect (LAA).
Bald Eagle (*Haliaeetus leucocephalus)*	Threatened.	Present.	No breeding, foraging, perching or roosting sites present at six of the seven project sites. Foraging, perching or roosting may occur in the vicinity of the Fenster Revetment Repair site during the fall and winter, well before and after the mid-summer construction season.	May affect, not likely to adversely affect (NLAA).

2 LOWER GREEN RIVER CONDITIONS

2.1 *Green/Duwamish Watershed Overview*

The climate in the Green/Duwamish River watershed is generally mild, with wet winters and dry, cool summers. Annual precipitation varies widely, ranging from over 100 inches in the Cascade foothills and decreasing westward to 35 inches in Seattle. The human population in the Green/Duwamish watershed, estimated to be 564,900 in the mid-1990s, is mostly concentrated within the lower (west) end of the watershed, but the fastest rate of population increase is in the suburban cities and nearby unincorporated areas east of Seattle (King County 1995).

The Green/Duwamish River (WRIA #09.0001) is a 6^{th}-order, 91-mile long stream that originates in the Cascade Mountains nearly 30 miles northeast of Mount Ranier and flows into Puget Sound at Elliott Bay in Seattle. The Green River basin (a.k.a. Water Resource Inventory Area (WRIA) 9) comprises 566 square miles and is bounded on the north by the Cedar-Sammamish watershed (WRIA 8), and to the south by the Puyallup watershed (WRIA 10). The mean annual flow in the lower Green River (measured at the Auburn gage) is 1,350 cfs, the average historic minimum flow prior to construction of Howard Hanson Dam (HHD) was approximately 140 cfs, and the maximum historic recorded flows is 28,000 to 30,000 cfs. Since construction of HHD, the average minimum flow is 210 cfs, and the maximum recorded flow was approximately 12,300 cfs in 1995.

2.2 *Green River Basin Physiography*

The basin can be divided into five physiogeographic parts: the headwaters (headwaters to HHD at RM 64.5); the upper Green River (including the Green River gorge; HHD, to Flaming Geyser State Park at RM 46.4); the middle Green River (Flaming Geyser State Park to the Soos Creek confluence at RM 33.8); the lower Green River (Soos Creek confluence to the Black River confluence at RM 11.1); and the estuary, a.k.a. the Duwamish River, from the Black River confluence to the mouth at Elliott Bay (RM 0.0). This study focuses on the lower Green River (RM 11.1 to 33.8), which encompasses most of the action area. The following summary description of the watershed is presented to provide context for the discussion of environmental pathways and indicators presented in Chapter 10.

<u>Headwaters</u>: From the vicinity of Blowout Mountain and Snowshoe Butte, the river flows generally west and northwest for approximately 25 miles through narrow valleyed, steeply sloped, densely forested terrain, gathering flows from Sunday, Sawmill, Champion, Smay and Charlie Creeks, as well as from the North Fork Green River. Tacoma Public Utilities (TPU) operates a well field in the North Fork Green River drainage above Howard Hanson Dam (HHD). The well field, developed in 1977, consists of seven wells, which can be used to withdraw water from an unconfined aquifer at depths ranging from 65 to 103 feet. This water is used to replace or supplement surface water withdrawn from the Green River at TPU's RM 61.5 water supply headworks. When the turbidity of Green River surface water approaches five NTUs, the North Fork well field provides a source of clean groundwater that allows TPU to provide the public with water that meets federal and state water quality standards. In general, pumping from the North Fork well field occurs during the late fall, winter and spring when turbidity increases as a result of storm events and resultant high streamflow, which sometimes triggers landsliding and/or mass wasting in the heavily logged upper Green River watershed and erosion of the HHD reservoir shoreline.

Upper Green River: Immediately below the North Fork confluence at approximately RM 64.5 is HHD, which the USACE constructed in 1961 as a flood control facility. The reservoir behind the dam currently provides up to 106,000 acre-feet of storage at elevation 1,206 feet. Water stored behind HHD during the summer is used to provide downstream low flow augmentation, and plans are underway to expand the summer conservation pool storage capacity to further augment summer low flows and provide occasional releases in the spring that would simulate natural freshets in the spring and early summer. No upstream or downstream fish passage facilities were included in the original HHD project because of the fish passage blockage 3.3 miles downstream at the Tacoma Public Utilities (TPU) headworks.

At approximately RM 61.0 TPU maintains municipal water supply diversion facilities which have blocked anadromous fish migration since construction of this facility in 1913. Volunteers from Trout Unlimited capture and truck adult salmon and steelhead upstream from this passage barrier for release above HHD. As mentioned above, Tacoma Public Utilities and USACE are currently proposing to store 5,000 acre-feet of water during drought years to provide additional water for downstream low flow augmentation.

Construction of TPU's headworks and HHD together have resulted in the loss of anadromous fish access to 29.8 miles of mainstem and 6.9 miles of side channel habitats, as well as 66.8 miles of tributary and 3.3 miles of tributary side channels. In addition to loss of access, the HHD reservoir inundates several miles of mainstem and tributary habitat, converting it from formerly highly quality spawning and rearing habitat to less valuable rearing and transportation habitats. A temporary adult fish trap is currently operated on the right bank at the headworks. This trap is used to capture adult steelhead for transport upstream of HHD and artificial propagation. At present, adult chinook and coho salmon are not trucked above the dam, but juveniles are outplanted in the upper watershed. Outmigration of juvenile salmonids of all species is currently grossly impaired by the design of the dam, which provides egress through an opening in the dam located approximately 150 feet below the spillway surface. In the relatively slack water conditions within the reservoir it is extremely difficult for salmonid fry and even yearlings to find this orifice, let alone survive after passing through it. Tacoma Public Utilities has installed temporary screens downstream of the headworks trashrack in an effort to reduce the entry of juvenile salmonids into the water supply system. Currently these screens do not meet criteria established by WDFW. Many elements of these fish passage facilities are proposed to be modified to correct fish passage and survival problems in TPU's draft habitat conservation plan (HCP) (Tom Nelson, King County, pers. com., 1999).

Below TPU's diversion, the river flows between narrow, steeply sloped valley walls through mostly forested mountain terrain before emerging from the mouth of the Green River gorge at approximately RM 46.4 at the upstream end of Flaming Geyser State Park.

Middle Green River: From upper Flaming Geyser State Park, the river flows through a broad, gently sloped valley in mostly agricultural land uses. In contrast with upstream areas, extensive portions of this reach are affected by levees and revetments that constrain channel migration while not necessarily containing floodwaters. Within Flaming Geyser State Park (RM 43.3 to 45.0), and Metzler/O'Grady (RM 38.9 to 39.6) and Auburn Narrows Parks (RM 32.6 to 33.7), owned by King County, the river is largely bordered by forested land and is less subject to bank armoring. As a result, these areas exhibit more natural riverine and riparian habitat characteristics.

Lower Green River: Downstream from King County's Auburn Narrows Park at RM 32.6, the river enters increasingly urbanized areas within the Cities of Auburn, Kent and Tukwila, where, except for occasional stretches of riparian park land, the river is bordered by an increasingly densely developed mixture of residential, commercial and industrial land uses. The entire Green River mainstem throughout the action area (RM 33.3 to 14.5) is in a highly degraded condition, with overall poor habitat quality. Habitat degradation in this reach began in the mid- to late-19th century, when early Euro-American settlers converted the valley floor to agricultural land uses. With continuing development in the Green River Valley during the mid- to late-20th century, incremental channelization and bank hardening efforts were carried out, culminating in the 1960s and 1970s, when the present extent of channel simplification and bank hardening was completed. As a result of decades of these landscape modifications, most of the remaining remnant side channels and tributaries are now disconnected from the active floodplain, and few pieces of LWD remain in the stream. The construction of nearly continuous system of revetments and levees within this reach has also decreased inputs of salmonid prey species (mainly insects) by eliminating functional riparian habitats along many miles of the river channel.

Other causes of habitat degradation within this reach include aggressive removal of the enormous volumes of LWD that filled the historic channel and off-channel aquatic habitats within the floodplain; construction of roads, bridges, drainage systems and other urban infrastructure; inputs of nonpoint pollutants from agricultural sources and urban stormwater; wholesale removal of riparian vegetation from the riverbanks and its replacement by narrow strips of invasive non-native species (primarily blackberries and reed-canarygrass); and filling and development of much of the historic floodplain for agricultural, residential and commercial land uses. Additional information about conditions within this reach is provided in the individual project chapters, and in the discussion of environmental pathways and indicators in Chapter 10.

Estuary: Downstream from the Black River confluence (RM 11.1), which is also considered the upstream limit of tidal influence, the Green River continues as the Duwamish River, which flows past scores of industrial and commercial facilities, as well as scattered urban parks and single- and multi-family residences. The Duwamish River and Elliott Bay have been extensively modified over the last 100 years, including the filling of 99 percent of their original wetlands (riparian swamps, high and low salt marshes, unvegetated tideflats and gravelly beaches), and shallow subtidal habitats (eelgrass and kelp beds). These habitats have also been adversely affected by extensive river channelization and dredging (Bortelson et al. 1980). As noted by Thom et al. (1994), such modifications can cause an array of ecological effects, including short term construction impacts, direct burial or displacement of riparian and nearshore habitats, and indirect impacts on habitat via disruption of riverine and littoral sediment supply. Substantial sediment contamination and water quality problems have also been documented in the Duwamish River and Elliott Bay, its receiving embayment of Puget Sound (Ecology, 1998). All of these habitat modifications have taken a severe toll on estuarine salmonid habitats.

2.3 Lower Green River Water Quality

The lower Green River and its tributaries are classified by the Washington State Department of Ecology (WDOE) as "Class A" (excellent). Class A waters can be used for water supply, stock watering, fish and wildlife habitat, recreation, and commerce and navigation. When systemwide monitoring programs detect that water quality standards are not being within a waterbody, WDOE can propose it as impaired under current water quality laws, including the federal CWA, Chapter 90.48 RCW and Chapter 173-206 WAC. The Green River is on WDOE's 1998 proposed Clean

Water Act Section 303(d) list of "troubled waterbodies" for temperature, dissolved oxygen, fecal coliform and mercury.

Temperature and dissolved oxygen are of primary concern in the lower mainstem, and, unlike fecal coliform, can directly impact salmonid survival (Berman, 1998). Table 10.2 summarizes temperature conditions recorded over the past 25 years in the lower Green River, including sampling sites in as well as upstream and downstream from the action area reach.

Sources of fecal contamination within the lower Green River include agricultural land uses, failing septic systems, and pet wastes. Temperature exceedences are typically related to land use changes that decrease tributary shading and increase urban runoff. Temperature impairment may also be due to industrial wastewater inputs. Low dissolved oxygen may be related to high water temperatures and high biological oxygen demand caused by oxygen-consuming chemical and/or biological processes. Water quality problems in the lower river may be exacerbated during late summer/early fall low flow conditions by natural droughts and/or water withdrawals by the City of Tacoma.

The CWA directs that a total maximum daily load (TMDL) of pollutants be established for all waters on the 303(d) list in order to assure that the pollution load to a waterbody does not exceed its assimilative capacity. No TMDLs have been established for the lower Green River at the present time but it is likely that this will happen in the near future.

There are three Individual Industrial Wastewater Permits along the lower Green River that establish treatment and wastewater management requirements for each permitted facility. One (Emerald Downs) is for stormwater; the other two (Boeing DC and Texaco Kent) are for remediated groundwater. In addition, there is one Municipal National Pollutant Discharge Elimination System (NPDES) Permit for King County's wastewater treatment plant (WTP) in Renton at RM 0.2 on the Black River, a short distance upstream from the mouth of the Black River at RM 11.1 on the mainstem of the Green River. The main WTP effluent discharge pipe is in Puget Sound, but there is an emergency discharge diffuser that runs along the bottom of the Green River perpendicular to the shoreline at RM 12.1. These permits are currently active and are meeting the discharge standards contained in their permits.

2.4 Lower Green River Fish Populations

In spite of elimination of a high percentage of habitats that existed in pre-settlement times, the Green River/Duwamish remains suprisingly productive of salmonids compared to other rivers within the Puget Sound basin. Six anadromous salmonid species historically or currently use the action area. These include chinook (*Oncorhynchus tshawytcha)*, coho (O. *kisutch)*, and chum (*O. keta*) salmon, steelhead/resident (a.k.a. rainbow) trout (*O. mykiss*), and resident and sea-run cutthroat trout (*O. clarki lewisi*) and bull trout (*Salvelinus confluentus*). Additional fish spawning and rearing occurs in certain of the side channels along the mainstem upstream from the action area, and in the lower and middle reaches of the larger tributaries of the Green River, including Mill, Soos, and Newaukum Creeks.

Chinook and coho salmon spawning occurs near one of the proposed project areas, the Fenster Revetment Repair site at RM 32.0. Chinook and coho rearing and migration occur throughout the action area. Bull trout rearing is possible but not well documented in the action area. Bull trout spawning is highly unlikely in the action area because suitable spawning habitat and water quality are not present.

~~1.4~~2.5 Status of Species Known or Thought to be in the Action Area

Fish

<u>Chinook Salmon (Oncorhynchus tshawytscha)</u>

Regulatory Status

Federal Status:	Threatened species
WA State Status:	Criteria 1, 2, 3 priority species[1]

Occurrence in the Action area

Puget Sound chinook salmon were listed by the National Marine Fisheries Service (NMFS) as a threatened species on March 16, 1999. The evolutionarily significant unit (ESU) includes all naturally spawned populations of chinook salmon from rivers and streams flowing into Puget Sound including the Strait of Juan de Fuca from the Elwha River, eastward including rivers and streams flowing into Hood Canal, North Sound, South Sound, and the Strait of Georgia in Washington.

Chinook are anadromous and semelparous. Within this general life history strategy, however, chinook display a high degree of life history variability, including variation age at seaward migration; variation in length of freshwater, estuarine, and oceanic residence; variation in ocean distribution and migratory patterns; and variation in age and season of spawning migration. In a review of the literature, Healey (1991) used differences in life history patterns to divide eastern Pacific chinook salmon into two broad races: stream-type populations and ocean-type populations. Green River chinook appear to fall into the latter category in that they migrate to sea during their first year of life–normally within three months after emergency from spawning gravel–and spend most of their ocean life in coastal waters, returning to their natal river in the fall, where they spend anywhere from a few days to a few weeks before spawning.

Another example of chinook life history variability is that expressed as the two so-called spring and fall chinook races. Fall chinook are currently far more numerous than spring chinook within the Puget Sound ESU, but the White River, a former tributary to the Green/Duwamish River, still supports a significant spring chinook population. Historically, a spring run also occurred in the watershed, but the re-routing of the White River into the Puyallup River in 1906, the re-routing of the Cedar River into Lake Washington and thence to the Ship Canal in 1916, the construction of the TPU

[1] Criterion 1. State Listed and Candidate Species. State listed species are those native fish and wildlife species legally designated as Endangered (WAC 232-12-014), Threatened (WAC 232-12-011), or Sensitive (WAC 232-12-011). State Candidate species are those fish and wildlife species that will be reviewed by the [D]epartment [of Fish and Wildlife] (POL-M-6001) for possible listing as Endangered, Threatened, or Sensitive according to the process and criteria defined in WAC-232-12-297.
Criterion 2. Vulnerable Aggregations. Vulnerable aggregations include those species or groups of animals susceptible to significant population declines, within a specific area or statewide, by virtue of their inclination to aggregate. Examples include heron rookeries, seabird concentrations, marine mammal haulouts, shellfish beds, and fish spawning and rearing areas.
Criterion 3. Species of Recreational, Commercial, and/or Tribal Importance that are Vulnerable. Native and non-native fish and wildlife species of recreational or commercial importance, and recognized species used for tribal ceremonial and subsistence purposes, that are vulnerable to habitat loss or degradation.

headworks in 1913 and the construction of HHD in 1961 eliminated access to much of the headwater habitat typically needed by spring chinook salmon. At present, spring chinook are occasionally found in the Green River, but it is not known whether these fish constitute a self-sustained run or are strays from nearby watersheds (Grette and Salo 1986).

Naturally spawning lower and middle Green River chinook mix with the Soos Creek hatchery stock, but fish that spawn in the upper Green River may be native (WDFW 1993). Coded wire tag recoveries indicate that some hatchery strays spawn naturally in the river (WDFW 1993), and up to 3,000 hatchery-produced chinook pass above the hatchery annually to spawn in Soos Creek (Eric Warner, MIT, pers. com. 2001). Adult returns to the Green River and its tributaries averaged 7,600 from 1987 to 1992 with an increasing trend (WDFW et al. 1993). The Green River chinook run far exceeded the 5,800 fish escapement goal in 1999, when 9,500 fish returned to the spawning grounds in addition to the 3,700 fish spawned at the Soos Creek hatchery (Pat Pattillo, WDFW, pers. com., 2000). In addition, the Muckleshoot (MIT) hatchery on Keta Creek rears chinook, coho, chum, and steelhead. Most of the MIT-produced chinook and coho are planted above HHD, and outmigrate as age 0+ fry in the spring or fall. A fraction of the MIT-produced coho planted about HHD outmigrate as age 1+ smolts in the spring after spending a year in the river.

Harvests have been severely curtailed in recent years due to lower than expected smolt-to-adult survival rates (WDFW et al. 1993) and the need to protect weak stocks in non-terminal areas (Pat Pattillo, WDFW, pers. com., 2000). The Green River chinook stock is currently only one of two within the Puget Sound ESU to receive a "healthy" rating (WDFW et al. 1993).

Adult chinook enter the river between August and September, and spawn between late August and November, with peak spawning in September and October (Phil Schneider, WDFW, pers. com., August 1999; WDFW et al. 1993). Adult chinook hold in deep pools for variable periods of time during their upstream migration. Based on adult chinook tracking studies in the Lake Washington watershed, the length of holding in pools may be influenced by water temperature, with longer holding periods occurring in drought years when water temperatures are unusually high during the late summer. Fish movement increases at night during dry weather, but even modest volumes of rainfall can stimulate upstream migration at any time of the day or night (Roger Tabor, USFWS, pers. com. 1999; Greenstreet 1992). Studies on chinook migration in the Sacramental/San Juaquin River system indicate that increased flow seems to flush outmigrants downstream, increasing their rate of passage. Survival of smolts passing through the Sacramento/San Joaquin River delta is highly correlated with the discharge of the Sacramento River (Groot and Margolis, 1991), presumably because accelerated downstream movement during high flows decreases the amount of time in which juveniles can interact with predators and other potential threats while moving toward the estuary.

Temperature cues either in the form of a threshold water temperature or a pattern of variation over a prolonged period may also trigger initiation of seaward migration. Time of release from the hatchery also influences passage time and survival. As seasons progress the riverine temperature and flows also change; therefore time of release is therefore a secondary influence related to seasonal changes in riverine conditions. Food availability at different times of year also influences the survival and overall health of the migrating juveniles. Lack of food may trigger predator abundance and feeding rates and efficiency may also have some influence upon on the timing of juvenile chinook migration (Greenstreet, 1992). The size of the juveniles during migration affects survival and passage because it influences the position in the river the fish choose to migrate within. Larger fish appear to prefer the middle, swifter moving water, whereas smaller fry choose the slower moving water along the banks (Groot and Margolis, 1991; Roger Peters, USFWS, pers. com. 1999). Smaller fish, therefore, migrate at a slower rate than larger fish and are exposed to the dangers of the river environment for a longer period of time.

Spawning occurs mainly between RM 29.0 to the City of Tacoma Diversion Dam at RM 61.0, and in the largest tributaries, Big Soos and Newaukum, although up to 31 percent of the spawning on the mainstem observed in 1999 occurred in gravel pockets and bars between RMs 24.0 and 29.0 (Rod Malcom, MIT, pers. com., 2000). Chinook spawning behavior is similar to that of other salmonids. The female selects an appropriate location over moderately coarse gravel and small cobble substrate and excavates to form a redd, backfilling as she proceeds upstream. After spawning, females have been reported to remain on their redds from four to 26 days until they die or become too weak to hold in the current (Neilson and Green 1981; Neilson and Banford 1983). Females will vigorously defend established redds against the spawning activity of newly arriving fish. Length of embryo incubation within the redd varies, depending on redd location and temperature, but is generally completed by the end of February.

Chinook fry reside in stream gravels for two to three weeks after hatching (Wydoski and Whitney 1979) before moving to lateral stream habitats (e.g., sloughs, side channels and pools) which provide refugia and food during their migration downstream to the Duwamish estuary and out to Puget Sound. Juveniles that are the progeny of naturally spawning fish emerge from the gravel in late February and March and spend anywhere from a few days to several months in freshwater before entering the Duwamish estuary (King County, 2000), depending on what is termed their rearing trajectory. Initially, fish inhabit the stream or river margin, but move into higher velocity regions as they grow; migrate mostly at night; and move with freshets (J. Anderson, pers. com. 1994). Different potential rearing trajectories are distinguished by habitat needs and duration of habitat use. In addition, the proportion of individuals within a year class conforming to particular trajectories may vary from year to year (Roni 1992). Hayman et al. (1996) has distinguished four potential chinook salmon rearing trajectories in the Skagit River, based on the timing of entrance to the estuary, which provide a useful framework for discussing juvenile chinook rearing in the Green River. These trajectories are as follows:

<u>Emergent Fry</u>: These fish migrate to estuarine rearing habitats immediately after emergency at a length of approximately 40 mm. Based on sampling in the Green/Duwamish estuary, fish conforming to this trajectory appear to be absent in WRIA 9 (King County, 2000), although fish this small have been captured in totally freshwater habitats located immediately upstream of the Duwamish estuary (Warner and Fritz, 1995). It is also interesting to note that releases of fed fry from hatcheries do not yield immediate catches of fry in the upper estuary (King County, 2000).

<u>Fry/Fingerlings</u>: After rearing for a variable number of days or weeks prior to migrating downstream, these fish migrate to estuarine or marine shoreline habitats at lengths varying from approximately 45 to 70 mm. These fish, which rear in both mainstem and side channel habitats within the middle Green River, have been captured in very high densities in a side channel near RM 34 (R2 Resource Consultants 1998). Small numbers of chinook less than 60 mm in length arrive in the freshwater-dominated habitats of the lower Duwamish River from April through May, corresponding with a decrease in density of fry of this size range observed in the middle Green River over roughly the same time period (R2 Resource Consultants 1999). This distribution suggests that small, naturally-spawned fish arrive in the estuary through the month of May.

<u>Fingerlings</u>: These fish, which include naturally-spawned and hatchery chinook, migrate to estuarine or marine shoreline habitats at a length of 70 or more mm. They are dependent primarily on freshwater

habitats within the Green/Duwamish River. The bulk of the migration by fish conforming to this trajectory occurs during May and early June, and the peak of migration is narrow (Weitkamp and Campbell 1980, Meyer et al 1980, Warner and Fritz 1995). The timing of arrival of these fish in the estuary is determined primarily by the timing of hatchery releases in May. Large chinook (>80 mm) have been found in the middle Green River (above RM 34) until late June (R2 Resource Consultants 1999).

Yearlings: These stream-type fish migrate to estuarine habitat at one year of age, but tend not to linger in estuarine and marine shoreline habitats.

A 1994 study of the distribution and growth of Green River Chinook salmon in the Duwamish estuary indicated that the timing of juvenile chinook outmigration is closely related to releases of fish from the Green River hatchery on Soos Creek. Juveniles were caught in the estuary during every sampling period from mid-February through early September, with peak catches occurring in mid- to late May (Warner and Fritz, 1995).

As mentioned earlier in this report, a number of factors affect the survival of chinook salmon in the Green River, including loss and degradation of instream and riparian habitat resulting from harmful land and water management practices, predation by native and introduced species in the river, droughts, floods, over-harvesting, and unfavorable ocean conditions. More detailed information about these factors is discussed in the pathways and indicators portion of Chapter 10. One factor worth noting here is the impacts HHD has on downstream passage of chinook juveniles. The MIT and WDFW began reintroducing anadromous fish into the upper watershed in 1982 (UCACE 1998) in an effort to take advantage of spawning and rearing habitat above the dam. In recent years, the 300,000 to 550,000 chinook juveniles outplanted in the upper watershed represent only about four percent of the total hatchery juveniles released throughout the watershed (King County 2000). It is estimated that the survival rate of these chinook and the similarly planted outmigrating juvenile steelhead migrating downstream through HHD ranges from five to 25 percent, with direct mortality in the bypass pipe in the outlet of the dam ranging from one to 100 percent, depending on conditions. Because of their small size at release, it is likely that chinook juveniles outplanted in the upper watershed, should they survive migration through the dam, would follow the fingerling or yearling rearing trajectories. However, there currently is no monitoring program aimed at tracking the downstream migration of these fish (Paul Hickey, TPU, pers. com., 2000).

To summarize, the majority of juvenile chinook migrating through the lower Green River appear to conform to the fry/fingerling and fingerling life history trajectories. Most of these fish arrive in the estuary during mid- to late May, but small numbers of chinook juveniles have been captured during the entire mid-February through early September time period monitored by staff of the MIT. Thus it is possible that low numbers of chinook juveniles could be present in the action area during summer construction window.

Bull Trout (Salvelinus confluentus)

Regulatory Status

Federal Status:	Threatened
WA State Status:	Criteria 1, 2, 3 priority species

Stock Status
Per WDFW 1998: Unknown

Occurrence in the Action area
Bull trout were proposed for listing by USFWS as Threatened under the ESA on June 10, 1998. The coastal/Puget Sound distinct population segment (DPS) includes fish present in the Green River.

Two native char species are potentially present in the Green/Duwamish River watershed: bull trout and Dolly Varden. Bull trout and Dolly Varden used to be considered to be the same species, but were recognized as separate species by the American Fisheries Society in 1980 based on differences in morphometrics, osteological features and embryological development (Cavender 1978). Both species have similar life history traits and habitat requirements (WDFW 1998). Populations of bull trout exist in several western Puget Sound drainages, including the Puyallup, Snohomish and Skagit Rivers (WDFW 1998), and a few bull trout have been captured in the Green/Duwamish River over the past 20 years. Dolly Varden also inhabit coastal drainages extending from western Washington to Alaska, and both species occur sympatrically in a number of western Washington drainages, including the Snohomish and Skagit Rivers. The species composition of native char in the Green River, will remain uncertain until comprehensive genetic analysis of native char populations is completed (WDFW 1998), but for purposes of this BA, only bull trout are addressed.

Bull trout exhibit three life history strategies: anadromous (fish that migrate between freshwater and salt water), fluvial (fish that migrate within a river system), and resident (non-migratory fish). Anadromous bull trout enter large Puget Sound river systems (e.g., the Skykomish River) from mid-May to mid-July, and reside in mainstem or large tributary channels for several weeks or months before migrating upstream to spawn in the fall in small headwater streams or lakes (Craig 1997; WDFW 1998). Most anadromous forms spawn only every other year, while resident bull trout may spawn every year (Armstrong and Morrow 1980; USFWS 1998). Upstream and downstream fish passage is influenced by the presence of physical barriers, hydrologic factors such as variations in the flow regime, and biological factors such as water quality, predation or behavioral responses to disturbances. Spawning sites are characterized by low gradient, relatively shallow depths, uniform flow and a gravel substrate between 0.25 and 2.0 inches in diameter (Wydoski and Whitney 1979; Fraley and Shepard 1989). Cool groundwater upwelling and proximity to cover are also important factors in spawning site selection (Fraley and Shepard 1989; Pratt 1992). Bull trout embryos incubate for approximately 100-145 days and hatch in late winter or early spring (Weaver and White 1985). Optimum incubation temperatures are between two and four °C. The alevins remain in the streambed, absorbing the yolk sac for an additional 65-90 days (Pratt 1992). Emergence from the streambed occurs in late winter/early spring (Pratt 1992). High fine sediment levels in spawning substrates reduce embryo survival, but the extent to which they affect bull trout populations is not entirely known (Rieman and McIntyre 1993).

Fry are usually found in shallow, slow backwater side channels and eddies, include proximity to instream cover (Pratt 1984). Young of the year (YOY) bull trout are found primarily in lateral stream habitats such as side channel areas and along stream margins, as is the case for fry of other salmonid species (Fraley and Shepard 1989). Juveniles are primarily bottom dwellers where they occupy interstitial spaces in gravelly substrate (Fraley and Shepard 1989; Pratt 1992). Sub-adults are often found in deeper stream pools or in lakes in deep water with temperatures less than 15 °C (Pratt 1992).

Long overwinter incubation periods for native char embryos and alevins make them particularly susceptible to increases in fine sediments (USFWS 1998). Washington Department of Fish and Wildlife lists the following limiting factors for native char species: stream temperatures which exceed the normal spawning and incubation temperature range; lack of spawning and rearing habitat; and a high percentage of fine sediments in spawning gravels (WDFW 1998). Because of their close association with the bottom, native char are sensitive to changes in the streambed (Fraley and Shepard 1989; USFWS 1998). Bull trout readily interbreed with non-native brook trout (Salvelinus fontinalis). Brook trout may also exclude bull trout from native habitats (USFWS 1998). Finally, native char are easily caught and thus are highly susceptible to fishing pressure. Therefore, any increase in the accessibility of a population to fishing pressure may negatively impact a population (Fraley and Shepard 1989; USFWS 1998).

In spite of numerous studies, information on the presence, abundance, distribution and life history of bull trout/Dolly Varden char in the Green River basin is extremely limited (WDFW, 1998). Bull trout were historically present in the watershed, but in recent years only a handful of sightings have been recorded, mostly in the estuary (Jeff Chan, USFWS, pers. com. 2000).

Staff of the U.S. Forest Service (USFS) determined that no records exist that suggest bull trout have ever occupied habitat upstream of HHD. In support of their Incidental Take Permit application for lands in the upper Green River watershed, Plum Creek Timber Company biologists conducted presence/absence surveys for bull trout in the Upper Green River mainstem and in Intake Creek, Sawmill Creek, Pioneer Creek, and Tacoma Creek in 1994 using the Hillman and Platts (1993) methodology. In 1995 Plum Creek staff surveyed the North Fork Green River, but no bull trout were found during these surveys (Jeff Light, Plum Creek Timber Co., pers. com. 1999). In a study of factors limiting salmonid production within the Plum Creek habitat conservation plan area within forested headwater catchments of the Green River, Watson and Toth (1994) concluded that it is unclear whether the upper Green River supports a population of bull trout, although the habitat surveys Plum Creek conducted above HHD were spotty (Scott Craig, USFWS, pers. com. 2000). While native char have been captured as far upstream as RM 40, Watson and Toth (1994) stated that it was impossible to determine whether the observed fish were fluvial or anadromous bull trout; instead these authors considered these fish to have been Dolly Varden. Lands in the upper watershed have been degraded by timber harvesting. Because of this and the fact that the Green River watershed headwaters lie at relatively low elevations ranging less than 3,500 feet, this system may not provide the cold waters and pristine habitat needed by bull trout during critical life history stages.

A single putative bull trout was captured in February 2000 by member of the MIT near the mouth of Newaukum Creek; definitive species identification at a laboratory in Montana is pending (Jeff Chan, USFWS, pers. com., 2000). There is more convincing evidence that anadromous bull trout regularly use the Duwamish River. In March 1978 MIT staff observed three anadromous char landed by non-Indian anglers within a 30 minute period at North Wind Wier (RM 5.8; Dick Moore, MIT, pers. com. 1978). In March 1994 an adult bull trout was recovered at RM 5.2 in the Duwamish River during a routine juvenile habitat utilization study by MIT staff (Rod Malcom, MIT, pers. com. 2000). Another native char was recovered by MIT staff in roughly the same location in the spring of 2000 (Eric Warner, MIT, pers. com. 2000), and several more subadults in the 250-300 mm size range were recovered by King County WLRD staff in the Turning Basin (RM 5.3, LB) in late August 2000 (Hans Berge, King County, pers. com. 2000). The species of the fish captured in 1994 was confirmed by genetic testing by staff of the University of Washington, the USFWS is currently assessing the genetic identity of the fish recovered this year (Scott Craig, USFW, pers. com. 2000), and species identification of the fish captured by King County staff is also pending. While it is conceivable that these fish originated in the upper Green River watershed, it seems more likely that they were migratory visitors from other watersheds where bull trout are more prevalent. These fish may have entered the Duwamish from Puget Sound to forage on outmigrating juvenile salmonids, which are abundant in the lower river during the spring. The fish captured in 1994 had salmonid smolts in its stomach (Eric Warner, MIT, pers. com. 2000).

In summary, there is evidence that native char may have historically occurred in the lower Green/Duwamish River (Grette and Salo 1986). Historical records report thousands of native char in the vicinity of RM 35 in the 1800s. It is noteworthy that this report was compiled prior to the diversion of the White River into the Puyallup watershed, where a bull trout population still exists (WDFW 1998). At present, however, water temperatures in much of the mainstem are unsuitably warm for bull trout over prolonged periods of time during the summer and early fall (Caldwell 1994). Another factor that likely limits bull trout populations in the Green River watershed is the existence of two long-standing total passage barriers: the TPU headworks, which has posed a physical barrier to passage between the lower and upper watershed for over 80 years, and HHD, which has posed a similar barrier for almost 40 years.

While structural habitat within portions of the action area may be suitable for bull trout during times of the year when the water is cool, the potentially lethal summer water temperatures— up to 73 ^{o} F recorded at several locations in the action area during multiple studies conducted over the past two decades (see Table 10.2)--coupled with the relative scarcity of juvenile salmonid prey in the action area during the mid- to late summer, make it unlikely that bull trout would occupy the action area during the construction season. It is conceivable that bull trout could hold in lower mainstem areas where cool springs create localized temperature refugia, but information is lacking on the locations of such springs. On balance, it is rather unlikely that bull trout would remain within the action area during the summer construction season (Jeff Chan, USFWS, pers. com., 2000).

Coho Salmon (Oncorhynchus kisutch)

Regulatory Status

Federal Status: Candidate
WA State Status: Criteria 2, 3 priority species

Occurrence in the Action area

Puget Sound coho salmon were proposed for listing by NMFS as Threatened under the ESA species on July 25, 1995. The Puget Sound/Strait of Georgia ESU includes what has long been considered as two Green River basin coho stocks: the Green River/Soos Creek stock, and the Newaukum Creek stock (WDFW et al. 1993), both of which rear throughout the action area. In fact, coho are considered to be the most numerous anadromous fish in the Green/Duwamish basin (King County 1978). The Green River/Soos Creek stock is of mixed origin, meaning that it consists of both hatchery fish and naturally spawning fish. The naturally spawning component consists of both wild fish that spawn upstream from the Soos Creek hatchery in both Soos Creek and in the mainstem and certain upstream tributaries. Releases of both native and non-native hatchery coho fingerlings in this system occurred from 1952 to 1962, and from the mid-1970's until 1997. Currently, approximately three million yearling coho are released annual from hatcheries on Soos and Crisp Creek. Escapement data for the Green River/Soos Creek coho stock are limited, however run reconstruction data indicate that escapement is stable and the stock is considered healthy (WDFW 1994).

The degree of exchange of genetic material between these hatchery released and wild coho in the Green River watershed is unknown. At present, there is no effective genetic research tool (e.g., electrophoresis) available for these fish, and no way of further distinguishing stocks beyond Green River coho and Newaukum Creek coho (King County 2000). Coho returning to Newaukum Creek have been considered to be a separate stock based on geographic separation and differences in run timing (WDFW 1994), although research currently being conducted suggests that the fish that spawn naturally in Newaukum Creek may simply be a mixture of native Green River and hatchery stocks (Jim Scott, MIT, pers. com., 2000). It is interesting to note, however, that coho returning to Soos Creek and the Green River typically spawn into mid-November, while those that return to Newaukum Creek spawn into mid-January (WDFW et al. 1993 and WDFW Spawning Ground Survey Database). Since 1987, the Newaukum Creek stock has declined precipitously and is considered depressed (WDFW 1994).

Like all eastern Pacific salmon, coho are anadromous and return to their natal streams to spawn. Coho salmon have a relatively simple life history pattern. Juveniles spend approximately 15 to 18 months in freshwater and emigrate to the ocean after their second spring. After spending 18 months at sea, where they grow to maturity, adult coho return to their natal streams to spawn. In many coho populations, a percentage of fish (typically males, a.k.a. “jacks”) vary from this pattern by returning to spawn after only one summer in saltwater. In some populations, a significant percentage of juveniles spend an extra year rearing in freshwater (Sandercock 1991).

After growing to maturity in the marine environment, adult coho return to the Green River and migrate upstream from early August through late January. As noted above, spawning occurs from November through late January (WDFW 1994; Caldwell 1994). Mainstem spawners utilize suitably sized gravels in and along the margins of the mainstem and in some of the side channels between RM 27.0 and the TPU headworks. Little if any spawning occurs downstream from RM 27.0 because the river below this point generally lacks riffles due to its inherently low gradient and decreased gravel supply. Perkins (1993) found that downstream from RM 25, the river is sand-bedded, indicating that virtually all gravel has dropped out upstream.

Length of incubation varies with location and temperature, but generally occurs approximately one month later than chinook, between early March to mid-May (McMahon, 1983). Coho embryos spend two to three weeks (depending on the volume of food stored in the yolk sac) absorbing the yolk sac in the gravel before emerging into the river.

A recent study of juvenile salmonid use of lateral stream habitats found that juvenile coho use the river margins and off-channel habitats near the Porter Levee at RM 34.3 from late March through the end of June (R2 Resource Consultants 1998). In addition, USACE staff (Fred Goetz, USACE, pers. com. 1999) found coho juveniles in a side channel immediately downstream of the Porter levee. Newly emergent fry usually congregate in schools in pools of their natal stream. As juveniles grow, they tend to move into riffle habitats and aggressively defend their territory, resulting in displacement of excess juveniles downstream to less favorable habitat (Wydowski and Whitney 1979). The aggressive behavior of juvenile coho may be an important factor maintaining the numbers of juveniles within the carrying capacity of the stream, and distributing juveniles more widely downstream. Once territories are established, individuals may rear in selected areas of the stream feeding on drifting benthic organisms and terrestrial insects until the following spring (Hart 1973). Juvenile coho rear in freshwater for approximately 15 months prior to migrating downstream to the ocean, but may extend their freshwater rearing time to two years (McMahon, 1983). The peak of coho smolt outmigration occurs between late April and late May.

Because of their prolonged residence in freshwater, the lower Green River habitat alterations described in earlier sections of this BA would presumably have an even more deleterious effect on coho than on chinook salmon. The vast majority of pool habitats that exist in the lower river consist of long, fast-velocity lateral scour pools at the toe of flood control facilities along outside river bends or convergence pools downstream from bridge abutments (Andy Levesque, King County, pers. com., 1999).

Sustrate can play a major role in the availability of salmonid food in streams. Areas with sand and silt substrate do not support a wide variety of readily accessible, preferred prey items such as chironomids, ephemeropterans and plecopterans (Higgs et al., 1995; Allan 1995). Such aquatic prey organisms typically occur in gravel and cobble substreates. Rivers Section staff have observed that the lower river is relatively deficient in benthic and terrestrial invertebrates compared to gravelly areas upstream in the mainstem and tributary reaches that support high densities of benthic invertebrates (Ruth Schaefer, King County, pers. com., 1999). These observations are consistent with the "river continuum" concept that holds that the distribution of stream invertebrates reflects a continuous gradient of physical conditions that affects the biological components in a river including the location, types and abundance of food resources with stream order (Vannote et al. 1980). Small-sized to medium-sized, forested lotic ecosystems (stream orders 1-3) receive large inputs of allochthonous matter (e.g., leaf litter and wood) from the surrounding watershed, whereas large, high-order river systems--especially ones such as the lower Green River, which exhibits a heavily urbanized floodplain and minimally vegetated riparian zone, receive relatively low inputs of allochothonus materials. Fewer species of aquatic or terrestrial insects are present at high densities in large, low-gradient riverine reaches than in headwater and mid-sized streams (Gore, 1978, Vannote et al. 1980, Merritt et al. 1984).

Table 2.1 Summary of the Features Important in the River Continuum Concept[1]

Feature	Headwater	Mid-Sized Streams	Large Rivers
Stream Order	1-2	3-5	6-9
Channel	Confined	Moderately Confined	Wide
Riparian Growth	Dense (stream channel covered at least part of year)	Moderate (majority of channel exposed)	Low (only stream margins covered; organic input is minimal)
Shading	High	Moderate to Low	Low
Substrate	Boulder, cobble, and gravel	Generally cobble and gravel	Gravel, sand, and silt
Water Temperature	Low and stable	Highly variable	High and stable
CPOM-Coarse Particulate Organic Matter	High (input from riparian growth)	Moderate (from upstream and little new input)	Low
FPOM-Fine Particulate Organic Matter	Low	High (flowing from upstream and produced here)	High (flowing from upstream and produced here)
Primary Production	Low (low algal growth due to little direct light)	High (high algal growth due to direct light and low turbidity)	Low (low algal growth due to insufficient light and substrate conditions)
Shredders	High	Low	Low
Collectors	High	High	High
Grazers	Low	High	Low
Predators	Low	Low	Low

[1]From Vannote et al. 1980.

The observed paucity of aquatic insects is also consistent with studies of aquatic insect populations in natural and artificial stream channels in response to varying degrees of suspended sediment deposition. Benthic insect density in artificially sedimented riffles was one-half that in unsedimented riffles, but the abundance of drifting insects was not significantly smaller in the sedimented channel. In a natural stream riffle, benthic insects were 1.5 times more abundant in a plot that was cleaned of sediment (Bjornn et al. 1977).

The lower Green River mainstem is also deficient in hydraulic refugia and escape cover due to extensive channelization, elimination of off-channel areas, and relative paucity of riparian vegetation from downstream downtown Auburn (RM 31) to the head of tidewater, compared to reaches upstream from Auburn. It is possible that the reason juvenile salmonids, including coho, have been observed to use lateral habitats much more than the mainstem (Jeanes and Hilgert 1998; Rod Malcom MIT, 1994 pers. com.) is because these habitat alterations have made the lower mainstem less hospitable to juvenile fish than lateral habitats. Another factor that potentially limits coho rearing habitat in the lower Green River at least during the summer is high summer and early fall water temperatures mentioned in the foregoing discussion of bull trout. More information about water temperature problems is presented in Chapter 10.

The actual extent and timing of habitat utilization of the lower Green River by juvenile coho salmon is currently unknown. At present, staff of WDFW are conducting the second year of a study of juvenile salmonid abundance and outmigration timing in the mainstem Green River using a floating screw trap. Because the trap is located at RM 34.5 just upstream from the Porter Levee, well above the action area of the proposed projects addressed in this report (King County 2000), it is unlikely to yield detailed information about fish use in the action area, but it may help pinpoint the timing of coho outmigration. In addition, consultants for USACE began a study in early 2000 to measure emergence, growth, movement, relative abundance and species distribution of juvenile salmonids in lateral habitats of the Green River over a three year period (King County 2000). A third study by King County staff is slated to begin in early 2001 using beach seining and fyke net sampling methods in the lower Green River (probably in the vicinity of RM 11) to collect information about juvenile salmonid outmigrating timing, growth and survival to complement information derived in the previously initiated studies. Based on the results to date of the abovementioned studies, it can be concluded that relatively low numbers of juvenile coho salmon are likely to be present in the action area during the summer construction season. A few adult coho may be present in the action area toward the latter part of the summer construction season.

<u>Bald eagle (Haliaeetus leucocephalus)</u>

Regulatory Status

Federal Status:	Threatened
WA State Status:	Threatened, Criterion 1 priority species

Range

The bald eagle is found throughout North America, but breeds mainly in Canada, Alaska, the Pacific Northwest, the Rocky Mountain and Great Lakes states, Florida and Chesapeake Bay. Eagles winter over most of the breeding range, primarily from southern Alaska and southern Canada southward (American Ornithologists' Union 1983, USFWS 1886).

Washington State and Local Distribution

Bald eagles reside near waters west of the Cascade Mountains, with scattered breeding areas in eastern Washington. Most nesting territories are located on the San Juan Islands, the Olympic Peninsula coastline, and along the Strait of Juan de Fuca, Puget Sound, Hood Canal and the Columbia River. Additional bald eagle nesting territories are found in portions of southwestern Washington, the Cascade Mountains and east of the Cascades where adequate ~~pre~~ resources are available. The primary winter range of bald eagles includes the Olympic Peninsula, the San Juan Islands, Puget Sound/Hood Canal and their major tributaries, and the Cowlitz and Columbia Rivers. According to the WDFW priority species database, there are no known bald eagle nests within the bald eagle action area, although two bald eagle habitats exist on the plateau west of Interstate Highway 5 (I-5; see Figure 1.1) beyond the action area. Wintering bald eagles frequent the Cedar River southeast of Renton several miles east/southeast of the action area.

Habitat Requirements

Bald eagles occupy areas near saltwater, riverine and lacustrine shorelines. Territory size and configuration are influenced by a variety of habitat characteristics, including availability and location of perch trees for foraging, quality of foraging habitat and distance of nests from waters that provide adequate food supplies. In Washington, breeding territories are located primarily in ~~coniferous,~~ uneven-aged coniferous forest stands with old growth components (Anthony et al. 1982) usually within unobstructed view of nearby water. Factors such as relative tree height, diameter, species, form, position on the surrounding topography, proximity to water and distance from disturbance appear to influence nest site selection. Bald eagle nests (also called aeries) can become quite large and bulky, attaining weights up to one ton as they are refurbished over successive years. While territories remain relatively constant from year to year, they may contain alternate nests. Grubb (1980) found that alternate nest trees in territories of Washington birds were located an average of 350 meters (1,050 feet) from occupied nests. The reasons for construction of alternate nests are unclear, but they may facilitate successful reproduction if the primary nest is disturbed or destroyed. Within a territory, additional snags and trees with exposed lateral limbs or dead tops are used as perches, roosts and defense stations (USFWS 1986).

The three main factors affecting distribution of nests and territories are: (1) proximity of water and availability of food, (2) suitable trees for nesting, perching and roosting, and (3) the number of breeding-aged eagles in the vicinity (Stalmaster 1987) . Grubb (1980) found an average territorial radius of 2.5 kilometers (1.6 miles) in western Washington. Nests are usually within one mile of water (USFWS 1986). The average territory radius ranges from 1.55 miles in western Washington to 4.41 miles along the lower Columbia River (Grubb 1980; Garrett et al. 1988).

Life History

In western Washington, courtship and nest rebuilding activities normally begin in mid-January, closely followed by egg laying from through late February. Incubation occurs from mid-January through late February. Egg incubation may begin as early as mid-January and end as late as late March. Eaglets hatch over a two-day period, typically in late March. Eaglets are reared in the nest by both parents over a period that may begin as early as mid-March and end as late as mid-July. Eaglets fledge from the nest between mid-June and late July (Anderson et al. 1986). Fledglings continue to be fed by their parents and remain close to the nest for several months, and may remain in the parents' territory for up to two years before staking out their own territories. Reproduction does not occur until age five. Both adult and subadult eagles may be present in the action area year around, but communal roosting and aggregation within riparian areas occur only in the winter, beginning in mid-October when salmonid carcasses start to accumulate, and ending in late February when carcass densities have declined (Kate Stenberg, King County, pers. com. 2000).

Wintering

On portions of the breeding range where waterbodies do not freeze, adult eagles may remain on the territory year-round. Juvenile eagles often drift from their nest area during the winter, eventually gravitating toward areas with concentrated food. Migrant eagles begin arriving at their traditional wintering grounds during late October (Anderson et al. 1986). Wintering bald eagles concentrate in areas where food is abundant and disturbance is minimal. The birds perch during the day, often communally. Perches are typically selected according to their proximity to a food source (Steenhof et al. 1880 in USFWS 1986). Perch trees tend to be the tallest available, and preferred branches are consistently used. A variety of tree species, both live and dead, are used for perching (Stalmaster 1976). Wintering birds may roost communally at night near major foraging areas such as carcass-laden river banks. Roosts are typically established in isolated areas in old-growth stands that have trees larger than the surrounding trees. Roost trees are apparently selected according to height, diameter and growth form, and for the protection they offer from wind, inclement weather and human disturbance. Eagles may gather in staging trees located between the feeding grounds and roost trees prior to entering nocturnal roosts (Hansen et al. 1980, Anthony et al. 1982, Stalmaster 1987). Communal night roosts are traditionally used year after year and tend to be selected for favorable microclimatic conditions rather than for proximity to food and water, often in ravines or draws that afford protection from inclement weather (Hansen et al. 1980; Keister 1987; Stalmaster 1987).

Breeding

Bald eagles live 30 to 40 years in the wild, and potentially up to 50 years in captivity. Bald eagles begin to breed at four to five years of age. Breeding occurs only once a year, and some birds do not nest every year. Bald eagles typically build large nests made from sticks in mature trees, which are generally used over successive years. As shown in Figure 2.2, courtship and nest building activities of birds that nest in the Central Puget Sound region generally begin in January and February. Egg-laying begins in March or early April, with eaglets hatching in mid-April or early May. Bald eagles usually lay two dull white to bluish-white eggs in a clutch. Incubation lasts for 35 days. Both parents participate in incubation, feeding and defending the nestling after hatching. The nestling require up to three months of nurturing by their parents in order to develop sufficiently to fledge. Eaglets usually fledge in mid-July and often remain in the vicinity of the nest for another month. Parents continue to feed their offspring for several months after they fledge from the nest, and offspring may share their parents' territory for up to two years before departing to stake out their own territories (Kate Stenberg, King County, pers. com. 2000).

Feeding

Adequate and consistent amounts of easily accessible, uncontaminated food resources may be the most important component of wintering and breeding habitat for bald eagles (USFWS 1986, Stalmaster 1987). Eagles often depend on dead or weakened prey, and their diet may vary locally and seasonally. Carrion such as spawned-out salmon carcasses taken from riverine gravel bars and banks are important food items during fall and winter (Stalmaster et al. 1986, Stalmaster 1987). Live fish and ducks are taken as well, especially near hunting grounds that contain injured and dead birds.

Eagles are also known to eat anadromous and warm water fish; small mammals such as rabbits and squirrels; opossums; seabirds; and various forms of carrion during the breeding season. Activities that disturb eagles feeding during the winter can increase their susceptibility to disease and starvation due to excessive energy expenditures in response to disturbance (Stalmaster 1987).

Bald Eagle Habitat Elements in Relation to the Bald Eagle Action Area

Bald eagle habitat within the project has greatly decreased within the action area over past decades due to ongoing urbanization.

~~**Move to Effects Section: Check with Kelly McAllister re presence of BEs** (breeding residents and wintering migrants) in the Lower Green River valley.~~ All but one of the project sites (Fenster Revetment Repair at RM 32.0) are devoid of large trees, especially mature, broken-top coniferous trees preferred by bald eagles for nesting. ~~One~~ A large cottonwood snag that formerly existed just upstream from the Pipeline Levee Repair site (RM 22.1, RB), may have provided a suitable perching site in the past, but it fell over in a windstorm in November, 1999~~, but actual use has not been documented~~. A single cottonwood just upstream from the mouth of Mill Creek (RM 24.9, LB) provided a perch for one eagle regularly seen at this site preying on rock doves (*Columbia livia*) over a three year period in the early 1990s until the landowner cut it down. In addition, several bald eagle pairs and juveniles are present every year on the Cedar River in the Maplewood (RM 4.6) and Byers Bend (RM 12.5) reaches five to ten miles east of the action area. Only one project area, that surrounding the Fenster Levee Repair site, contains spawning habitat where salmon carcasses could accumulate and attract foraging eagles during the fall and winter. No spawning habitat is present at the other six sites. On balance, the likelihood of bald eagles being present at or near these seven project sites during the summer construction season seems rather low.

Table 2.2 Timing of ESA Listed, Proposed and Candidate Species' Life History Phases in the Green-Duwamish River Basin (WRIA 9)[1]

Species	Phase	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sept	Oct	Nov	Dec

Fall	Upstream Migration													■	■	■	■	■	■	■	■	■			
Chinook	Spawning																	■	■	■	■	■			
(listed T)	Incubation	■	■	■	■													■	■	■	■	■	■	■	■
	Juvenile Rearing		■	■	■	■	■	■	■	■	■	■	■	■											
	Juvenile Out-migration							■	■	■	■	■	■	■											
Bull	Upstream Migration										■	■	■	■	■	■	■	■	■						
Trout	Spawning															■	■	■	■	■	■	■	■		
(listed T)	Incubation	■	■	■	■	■	■	■	■	■						■	■	■	■	■	■	■	■	■	■
	Juvenile Rearing	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
	Juvenile Out-migration					■	■	■	■	■	■	■													
Coho	Upstream Migration	■	■													■	■	■	■	■	■	■	■	■	■
Salmon	Spawning	■	■	■																	■	■	■	■	■
(candidate)	Incubation	■	■	■	■	■	■	■													■	■	■	■	■
	Juv./Subadult Rearing	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
	Subadult Outmigration								■	■	■	■	■	■											
Bald	Courtship/Nest rebuilding		■	■																					
Eagle	Egg laying		■	■	■																				
(listed T)	Egg Incubation			■	■	■	■	■																	
	Eaglet Hatching							■																	
	Eaglet Rearing							■	■	■	■	■	■	■	■										
	Eaglet Fledging												■	■	■										
	Subadult Rearing	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
	Wintering	■	■	■	■																	■	■	■	■

[1] Data for chinook and coho are from WDF 1975; data for bull trout are from Rieman and McIntyre 1993, Kraemer 1994, City of Seattle 1998, USFWS 1998, and WDFW 1998; data for bald eagles are from WDFW 2000.

2.6 *Baseline Monitoring of Fish Utilization*

USFWS Technical Assistance Contract

In 1999 staff of the King County Rivers Section requested training and technical assistance from staff of the USFWS Western Washington Office in the development of a fish habitat utilization monitoring strategy for levee and revetment repair projects, including these seven projects on the Green River. The general goal of monitoring is to determine whether utilization by listed, proposed and candidate species (chinook, coho and bull trout) of conventional flood control facilities (i.e., those with oversteepened banks, lined with riprap above and below the OHWM[1], and devoid of

[1] The OHWM determinations for these projects are made in accordance with definitions codified in the Washington State Hydraulic Code (WAC 220-110-030(51)) and Shoreline Management Act (WAC 173-16-030(10)) rules, while taking into account the unusual hydrologic regime of the Green River. From late June through late October, controlled discharge of as little as 150 cfs from HHD allows seasonal establishment of water tolerant grasses and forbs at elevations on the riverbank that are usually inundated at other times of the year. Water tolerant woody riparian species such as willows, dogwood and Oregon Ash are almost never observed below the lowermost three feet of the exposed bankline. In fact, previous efforts to establish willows and other riparian species within this lowermost bank zone have routinely met with failure, as they are completely inundated during the early part of the growing season, from late February to mid-June. Close observation of the riverbanks shows that the waterward edge of a band of woody riparian vegetation is clearly visible some three feet in elevation above the uppermost limit of the forb zone. This is the elevation line above which riparian tree and shrub species normally establish in the Green River,

LWD) differs from those that have been retrofitted by bank resloping, removal of riprap above the OHWM and installation of large toe rock and LWD. In addition, monitoring will be conducted during construction to observe changes in fish behavior in response to construction activities.

The USFWS staff completed training of King County personnel in late August 1999 to teach King County personnel the methods USFWS staff have used to monitor fish habitat utilization at river bank stabilization projects and unaltered riverine sites along several western Washington rivers. For a complete description of that methodology, see Peters et al., 1999. The first round of habitat and fish utilization surveys at the seven project sites (plus a set of control sites) was conducted on three non-consecutive days between September 29 and October 18, 1999. Additional monitoring within at project sites and nearby control reaches is planned for the following times: (1) early summer just prior to construction, (2) during construction activities, and (3) following completion of the projects. The results of the surveys conducted to date are discussed in the individual project sections (Chapters 3 through 9), and the data forms are included in Appendix E.

Survey and Control Reach Selection

A set of survey reaches were designated within the project reaches and within a set of nearby control reaches. The selected control reaches were intended to be as similar as possible to the project site reaches in terms of channel form (e.g., outside bend vs. outside bend), hydraulic conditions, and mesohabitat type (e.g., pool, run, riffle).

Hypothesis Testing

Fish habitat utilization will be monitored at regular intervals over several years to determine if fish use of habitats at these project sites differs prior to, during and after these repairs projects, and if so, to what extent. The null hypothesis is that there will be no difference in salmonid habitat utilization at these seven project sites compared to salmonid habitat utilization at the set of unaltered control sites. Studies by USFWS (Peters et al. 1998), and the Skagit System Cooperative (Beamer and Henderson 1998) aimed at testing the same hypothesis indicate that salmonid usage of bioengineered flood control facilities does in fact exceed that of unaltered flood control facilities, and in some cases exceeds that of natural unaltered riverbanks, particularly those lacking LWD.

Habitat Survey Methods

Before fish abundance observations were conducted, a team of three surveyors mounted in float tubes conducted a habitat survey to characterize and measure habitat parameters within each project and control survey reach. These data were collected to quantify instream primary and secondary habitat types at each project site and at an associated control site to provide a basis for evaluating (1) the changes in habitat variables as a result of project implementation, and (2) fish utilization of the project survey reaches before and after construction compared with that of the control reaches over time. The habitat survey methods consisted of a modification of a five-level hierarchical habitat classification system developed by Hawkins et al. (1993). A set of pre-project habitat and fish utilization surveys were conducted in September, 1999 and a second set will be conducted over the spring of 2001. Fish habitat utilization will be surveyed at each site during construction. Post-project surveys will begin in the spring following construction.

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whether planted, or through natural succession. Since it is not possible to successfully plant woody shrubs and trees below this line, it is used in all GRFCZD facility repair designs as the OHWM for design purposes. The OHWM elevation derived in this fashion corresponds approximately with a discharge of roughly 1,500 to 1,800 cfs which is right in the range of the 20 percent exceedence probability for mean monthly flows in June and November, respectively.

Linear channel measurements were taken using a hand-held range finder, and depth measurements were taken with a two-meter stream survey staff. Substrate size and embeddedness were either measured or visually estimated. Primary and secondary habitat types were identified, and detailed bank characteristics were also collected for each habitat unit, including bank angle, percent riparian cover, percent vegetation overhang, length of undercut bank, and amount and complexity of different cover types (typically riprap, boulders and LWD). Bank angle was calculated as the inverse tangent of the rise (toe of bank to elevation of bankfull width) divided by the run (distance from toe to bankfull width) and subtracted from 180 degrees. A completely flat bank would be 180 degrees; a completely vertical bank would be 90 degrees, and a bank angle less than 90 degrees would indicate an undercut bank. River discharge during the survey was taken from the USGS measurement at the Auburn gage at the time of the survey. Water velocity in feet per second was measured using a hand held flow meter.

A separate LWD survey was conducted in September, 2000 by a two person crew plying the river in a canoe. Large woody debris was defined as woody material at least one foot in diameter and 25 feet in length observed between the toe of the facility and the center of the channel. Because much of the observed LWD was partially decomposed and obscured in murky water, no attempt was made to distinguish between coniferous and deciduous material. Pilings (which were usually found near the bank, but in some cases extended into the channel) were also counted.

Fish Abundance Estimation Methods

The initial efforts in 1999 to develop and test fish observation methods for monitoring salmonids on the lower Green River proved challenging. King County and USFWS staff mutually agreed that standard snorkel surveys were inadvisable because of health-related water quality concerns (hepatitis and fecal coliforms). An attempt was made to use an underwater video camera in lieu of full-face snorkeling, but the equipment proved cumbersome. The following are examples of the problems encountered: (1) the electronic gear was difficult to protect from moisture in a rubber raft with up to three people aboard; (2) video viewing helmets provided poor visual resolution of salmonids and other underwater features; (3) although a small television monitor provided excellent visual resolution in the shade, it was difficult to keep the screen oriented away from sun glare in a small, cramped boat floating downstream at constantly shifting solar angles, (4) it was difficult to identify fish from a distance using the television monitor because of light scattering caused by relatively high concentrations of fine particulate matter in the water column.

After testing different methods, a standard fishing float tube was selected as the surveyor platform for the 1999 surveys in lieu of a boat or rubber raft, which are difficult to launch along the near vertical blackberry infested banks of the lower Green River . A hand-held, 36" long, 6" diameter viewing tube constructed from polyvinylchloride pipe covered at one end by plexiglass was used as the in-water viewing device. Calibrating of this method alongside standard snorkeling procedures revealed that the viewing tube afforded less peripheral vision than viewing fish through an underwater snorkel mask. Therefore, viewing tube fish counts may be somewhat lower than snorkel counts.

In order to ensure that the same exact reach was surveyed by each member of the three person survey team, a floating plastic line was attached to fixed objects (e.g., large toe rock or a stout shrub or tree trunk) at the upstream and downstream ends of the survey reach. Starting at the upstream end of the survey reach, the surveyors floated one at a time downstream through the survey reach using the line for positioning the float tube two meters out from the bank, viewing the bank toe through the viewing tube. Each subsequent surveyor waited five minutes before starting the survey to avoid encountering sediment accidentally dislodged by the previous surveyor, and to allow any fish in the area to settle down after passage of the previous surveyor through the survey reach.

Monitoring Results to Date

Monitoring results for each project site are presented in the project descriptions in Chapters 3 through 9, and the survey manual and data forms are contained in Appendix E.

Future Project Monitoring Protocol Improvements

Further refinements to the monitoring protocol will be carried out during the spring of 2001. These include establishment of precise monitoring and control reaches using global positioning satellite (GPS) equipment, and further testing of automated observation equipment such as a conventional underwater camera, and an underwater video camera ("fish-cam") attached to a video recorder that could be installed at fixed locations to minimize disturbance to natural fish behavior patterns. These methods will be thoroughly documented in the first annual project monitoring report to be issued by December 31, 2001.

3 PROJECT DESCRIPTION AND SITE SPECIFIC INFORMATION, SEGALE LEVEE REPAIR.

3.1 Project Location

The vicinity of the Segale Levee Repair is shown in Figure 3.1, and the project area and project site are shown in Figure 3.2. The project site is at RM 15.4 on the left bank of the Green River within the City of Tukwila. The area lies in the Northwest and Northeast and Southwest Quarters of Section 35 of Township 23, Range 4 East Meridian, roughly due south of the intersection of Andover Park W. and S. 180th St.

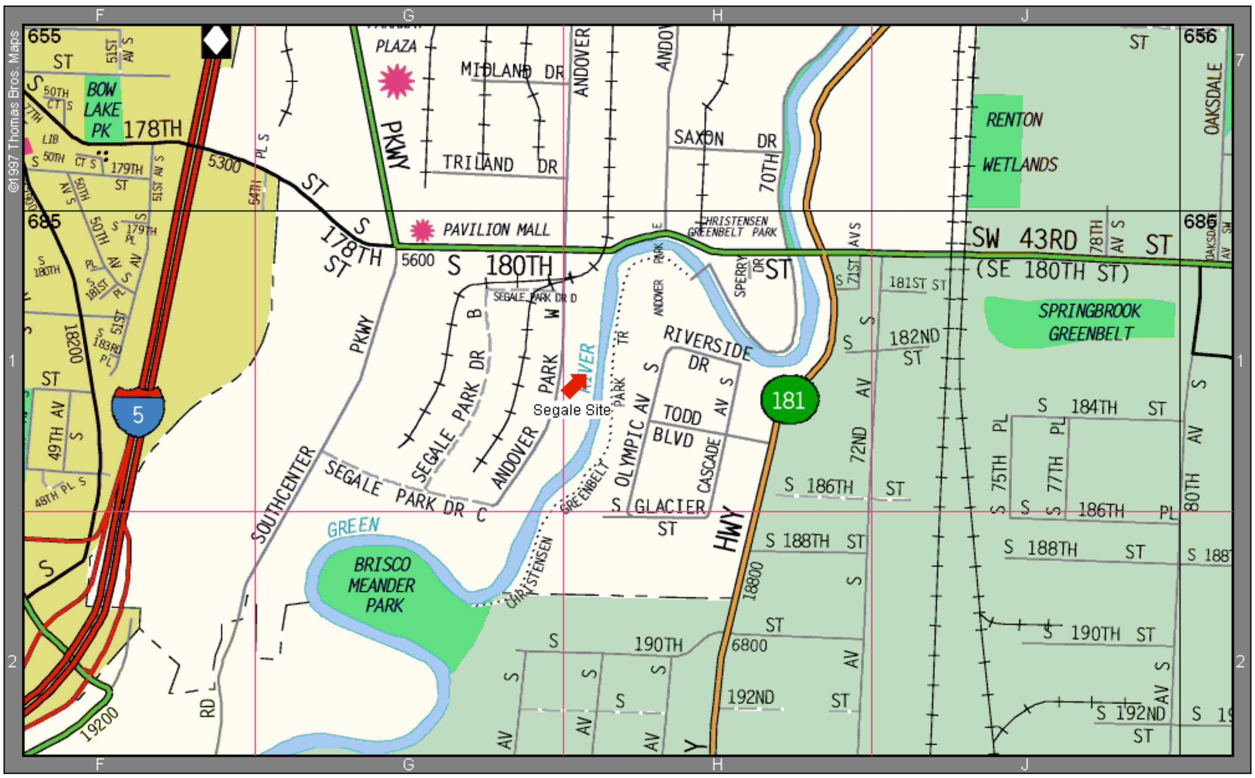

Figure 3.1. Segale Levee Repair Vicinity Map

3.2 Site-Specific Conditions

Segale Levee Repair Existing Site Characteristics (RM 15.4, Left Bank)

The Segale Levee Repair site is a 190 foot segment of the 4.1 mile long USACE Section 205 federally authorized lower Green River Flood Control Project that was built between RM 12.6 to 16.7 along the left bank in 1964 by King County. The facility was upgraded and accepted into the USACE Section 205 program in 1991. The repair reach examined for this report lies within land presently occupied entirely by commercial warehouses, light industrial factories, office buildings, parking lots.

The total channel width at the levee crest is approximately 120 feet, and the OHWM width is approximately 65 feet. The planform of the river within this reach is meandering; the 175 lineal foot facility repair site is relatively straight. The project site and adjacent reaches upstream and downstream show the effects of extreme channelization, bank hardening and floodplain filling to create commercial and industrial buildings, streets, parking lots, a railroad line and other public and private infrastructure. Hydraulic controls at this site include levee confinement per se (including the Desimone Levee on the opposite bank) and operation of HHD upstream by the USACE.

The streambed of this regime channel is composed of organic materials, silt and sand; no gravels, boulders or bedrock are present, except for rock materials that have sloughed from the facility toe into the channel. The facility is within a sediment accumulation zone, as evidenced by accumulation of sediment at the toe of the facility, and on a narrow bench part way up the bank. At the same time, it appears that erosion is episodic at this site, as evidenced by the toe erosion that will be corrected with this facility repair, and by localized slumping failures involving the narrow sand bench deposits downstream.

A survey of LWD abundance conducted in September 2000 revealed that 27 pieces of LWD installed as clusters into the toe repair work accomplished in 1996 exist along the toe of this levee, in addition to 21 pieces of old, partially decomposed pieces of woody debris along the bankline and embedded between the center of the riverbed and the left bank. The largest of these natural pieces is a single 35 foot long, 12-inch diameter log visible at low water on the inside bend just upstream of the site on the small sandbar present there, near RM 15.65. Nine relict pilings also exist in this reach along the toe of the levee. All of this wood does not add up to the volume of one of the log clusters installed into the Segale toe in 1996.

To date, there has been one documented survey of fish habitat utilization of this reach, done in gathering baseline monitoring background information in the fall of 1999 for preparation of this BA. No fish were observed, as is typical of observations of the lower Green River in late summer/early fall conditions (see Appendix E). Additional pre-project monitoring studies of fish utilization will occur during the first half of 2001. A plan for post-project monitoring is described in Chapter 11. Based on the results of studies by Peters et al. (1998) and Beamer and Henderson (1998) it is hoped that placing LWD in the repair reach may increase use by rearing juveniles due to increased cover and hydraulic refuge. This project, together with the Desimone Levee repair on a 1300 foot segment of the opposite bank, will add a total of 82 pieces of LWD in addition to the 20 pieces placed along the toe of the Segale Levee in 1996. These 93 pieces of LWD exceeds the properly functioning conditions (PFC) metric for a mile of coastal river channel (NMFS 1998). Of course, there is no guarantee of increased fish use as a result of these actions.

Past Repair Projects: The Segale Levee has been repaired seven times since 1983. Several of these repairs have addressed seepage and piping problems along the landward toe of the levee. The present toe repair site is within a 900 foot segment that was previously reconstructed by King County in 1996, and is immediately upstream from an additional 700 foot long riverward repair constructed by the USACE in 1991.

In 1989, UCACE performed levee rehabilitation work over a 700 foot-long reach of riverbank just downstream of these landward repairs, under their continuing authority granted under Public Law (PL) 84-99. King County serves as the local sponsor of this USACE non-federal levee rehabilitation program. Sponsorship consists of providing 20 percent of the funding and obtaining the permits for needed repair projects. To date, repairs have involved several hundred feet of the riverbank which slumped into the channel margins under saturated conditions following rapid drawdown of river stage due to evacuation of flood storage from the reservoir at HHD. The failed embankment materials were excavated and removed from the site, except for materials needed to provide soil cover for the completed repairs.

In 1991, the entire left bank levee system from RM 12.6 to RM 16.8 was raised by the USACE to consistently provide two feet of freeboard above the water surface elevation calculated to correspond to the USACE release of flows from HHD under flood conditions, consistent with the standard project flood (SPF) utilized for design and operation of the dam under its congressional authorization. This flow condition is limited to 12,000 cfs at Auburn and could last for up to nine days under 100-year flood conditions. Elevations were calculated by the USACE using an unsteady-state, two dimensional hydraulic model. Following completion of the additional levee freeboard lifts, the levee was accepted as a federally authorized project under the authority of Section 205 of the Flood Control Act of 1948. Tukwila is the local sponsor of record for this project. Through interlocal agreement with Tukwila, GRFCZD has agreed to carry out the levee maintenance obligations of the local sponsor for this portion of the levee system. Because it is part of a federally authorized Section 205 levee system, significant flood damages to the Segale levee could be repaired directly by USACE. Normal and routine maintenance would normally be carried out by the local sponsor, together with repairs that are not obviously the result of significant flooding. Tukwila could still perform maintenance on this system, and has easement rights to do so. However, King County, operating through GRFCZD, is the agency currently responsible for normal and routine maintenance and repair.

In the winter of 1995, significant saturation, near-liquefaction, and localized upwelling "sand boils" indicating incipient piping conditions were noted throughout a significant area between RM 15.3 and RM 15.5. In response to this condition, both King County and USACE mobilized a “flood fight” in order to excavate a 15-foot-wide, six-foot-deep trench along the entire landward levee toe from RM 15.1 to RM 15.5. This trench was backfilled with railroad ballast and quarry spalls to provide a foundation reinforcement and piping filter. Work was completed as an emergency repair, utilizing recommendations developed by Shannon and Wilson, a Seattle geotechnical consulting firm, for addressing these problematic foundation conditions.

During the summer of 1996, an additional volume of crushed railroad ballast fill was placed over the trench along the landward toe in this same reach. Additional lifts of crushed ballast were placed landward of this reinforcing buttress to provide both a piping filter and additional weight to resist uplift pressures associated with the seepage conditions. Work was accomplished in partial fulfillment of recommendations provided by Shannon and Wilson. Based on their conditions analysis, a design for constructing a series of relief wells discharging to a pumped outfall into the Green River was also developed.

Also in 1996, a construction bench was created the along the channel margin above the OHWM elevation to facilitate reconstruction of approximately 900 feet of the levee toe, which encroached about three to four feet into the channel in typical USACE fashion. The levee toe was reconstructed using a mixture of light-loose and heavy-loose riprap, with rock in the one foot to three-foot diameter range. This same rock, with a greater preponderance of light-loose riprap, was used to reconstruct the excavated levee face, which was then covered to a depth of up to two feet with native silts and sands retained from the excavation. For the first year or two following construction, settlement of the soil cover into the underlying rock voids was evident. However, flood-borne sediment deposits have subsequently filled in the voids thus created and vegetation has established on the stabilized lower slopes in a zone between the OHWM and eight to 10 vertical feet above the OHWM. This vegetation consists primarily of willows and black cottonwoods, and remains relatively sparse and immature. Invasive non-native blackberries (mostly *Rubus discolor*) and Scot's *broom (Cytisus scoparius*) have started to recolonize the upper bank above the willow/cottonwood zone. In accordance with USACE Section 205 maintenance standards, the upper bank was mowed in 1998 and in 2000.

In the winter of 1996, additional upwelling, "sand boils", and foundation liquefaction were noted during routine flood patrol along the toe area near RM 15.6, together with saturation and slumping of the landward levee face. Following emergency consultation with Shannon and Wilson, an additional increment of crushed railroad ballast fill was placed to form a seepage blanket and reinforcing toe buttress to reinforce the affected areas.

In the summer of 1997, oversteepened slopes along the riverbank were excavated, provided with a toe buttress incorporating several small LWD clusters, and rebuilt using clean sand and gravel fills interlayered with native soils and live willow cuttings. Fill lifts were wrapped with coir fabric for additional structural reinforcement, and to serve as an erosion control measure. Failed slope deposits were excavated from the slope to create a wide bench above the OHWM. Fifteen-foot-long increments of the toe slope were then excavated to allow for placement of toe rock and associated LWD clusters. The toe was constrained by the existing, eroded toe slope position, with no encroachment into the OHWM along the channel margins. This allowed for a very narrow margin in rebuilding upper slopes to a 2H:1V angle of repose, as recommended by Shannon and Wilson for this work. The 2H:1V slope angle is the minimum found necessary to meet required factors of safety for analyses of various slope failure mechanisms, including the condition of rapid drawdown of river stage following saturation of the riverbank due to release of floodwaters from reservoir storage. Depths of excavation for placement of toe rock were also constrained, due to the saturated, liquid soil conditions encountered at relatively shallow depths below the summer water surface elevations. Localized shifting of the channel along the toe appears to have scoured out riverbed sands along the channel margins over a 175-foot-long reach near RM 15.4 since initial construction. This has lead to the localized dislocations of toe rock which are the subject of the repairs addressed in this present BA.

During the summer and fall of 1998, the series of relief wells and related pumped outfall system designed under the recommendations of Shannon and Wilson were constructed between RM 15.3 and RM 15.4. These wells penetrate to a depth of 30 feet and are connected to a free-draining manifold at a depth of about 12 feet below the crushed rock toe berm within which they are situated. Drainage collected into the manifold is routed to a wet well consisting of a 96 inch diameter manhole, where it is the pumped directly to the Green River and discharged at the OHWM elevation onto the toe rock at the outfall location. Discharge only occurs flood conditions, when the pumped outfall is appreciably submerged under flood discharge elevations. The excavation trench for construction of the outfall line was revegetated with willow cuttings to King County specifications upon completion.

During the summer and fall of 1999, the landowner placed additional fills over the landward toe slope areas upstream of RM 15.4. A perforated seepage collection line was installed into the toe buttress between RM 15.4 and 15.5 as part of this work, which was permitted by the City of Tukwila. King County was not involved in the review or approval of the work in question. Additional filling of landward areas upstream of these repair locations has also been performed by the landowner under city permits for construction of commercial warehouses. The effects of this construction on the

Section 205 levee system have been reviewed and approved by the USACE as well. King County's requests for certain measures to accommodate slope stabilization and revegetation measures in future repairs were not incorporated into these approvals. While King County will continue to monitor this levee segment, upstream of RM 15.5, any significant repairs here will remain the responsibility of the USACE and Tukwila.

Habitat and Fish Utilization Surveys

Riparian Habitat: On October 18, 1999 King County and USFWS staff collected habitat data and surveyed fish utilization within a 60 meter length of the project reach, and within a 40 meter control reach located just distance upstream from the project reach (see data forms in Appendix E)[1]. The river discharge that day was 386 cfs at Auburn. The average flow was not measured in either the project or the control reaches. Little native riparian vegetation was present along the waterward slope of the levee in both the project and control reaches due to historic vegetation management practices, including maintenance of the levee in an oversteepened condition. Riparian tree canopy was absent along both the project and control reaches. Most of the riparian vegetation in both the project and control reaches consisted of willows installed on the lower bank during a repair of this facility in 1996, but these willows were not large enough to provide overhanging vegetation. The upper bank was largely unvegetated, except for grasses and a sprinkling of exotic species (mostly Himalayan blackberry and Scot's broom). The vegetation on the landward slope of the levee consisted of sparse grasses and herbaceous weeds. There was no tree canopy on the landward slope of the levee or in the riparian zone landward of the levee, which is occupied by a parking lot, a seepage relief well system, a pump station and an industrial warehouse.

Instream Habitat: Within the project reach, a 60-meter long habitat unit was identified, characterized as a narrow, relatively shallow lateral scour pool slow-moving water. Within the control reach, a 40-meter long habitat unit was identified, characterized as a narrow, relatively shallow lateral scour pool with slow-moving water. Instream cover within the project reach consisted of a 60 meter stretch of toe rock boulders, and four meters of LWD. The substrate in both the project and control reaches consisted of moderately embedded silt and sand. The overall habitat complexity in the project reach was judged to be moderate because of the cover afforded by the toe rock boulders and LWD. The overall habitat complexity in the control reach was judged to be low (a.k.a. sparse) because it consisted only of boulders.

Fish Survey: No fish were seen in either the project or control reaches.

Future Surveys: Additional habitat and fish surveys are planned starting in February 2001

3.3 Proposed Action

The primary goals of the Segale Levee Repair project are to (1) restore structural stability to a 190-foot segment of the Segale Levee damaged by toe scour during the 1995-1996 floods, and (2) improve instream and riparian habitat for salmonids and terrestrial wildlife.

This project, currently proposed for mid-summer construction sometime between 2001 and 2003, includes (1) replacement of large toe rock displaced during recent floods; instream installation of 20

[1] This same 40 meter control reach was also designated as the control reach for the Desimone Levee repair project on the opposite bank.

pieces of coniferous LWD (all but three of which will have intact rootwads) parallel to the bank, anchored to large toe rock; (3), installation of live willow and red-osier dogwood brush layers within all disturbed portions of the lower bank, and (4) revegetation of the middle and upper bank with native shrubs during the ensuing plant dormancy season (October 1 through February 28).

3.4 Purpose and Need

The purpose of this levee repair is to prevent channel migration and contain floodwaters within highly urbanized areas of Tukwila, including the Southcenter Shopping Mall a short distance downstream from this project site. This repair will also provide an opportunity to improve salmonid habitat within the Segale Levee reach of the lower Green River by ameliorating at least two factors of decline noted in a recent assessment of habitat limiting factors in the lower Green River (King County 2000), namely deficiency of LWD and deficiency of riparian vegetation.

3.5 Construction Activities

Temporary Erosion and Sediment Control (TESC)

1. The following will be brought to the site and staged on a daily basis as needed:
   - Straw bales for slope mulching
   - Silt fencing for perimeter siltation control
   - Crushed or washed rock for control of soil pumping on exposed soils in heavy traffic areas
   - 5/8 inch minus crushed rock for staging areas and road shoulders
   - Pea gravel for filter berms and silt fence installations
   - Hand brooms, street sweepers, and wash trucks for control of sediments on paved traffic surfaces

2. A turbidity curtain (see Figure 10.1 and Table 10.5) will be installed prior to in-water construction

3. All in-water construction will occur between June 15 and August 15 (or as otherwise authorized by permit conditions), to avoid extended periods of rainy weather and high river discharge, and to coincide with the period of minimum habitat utilization by juvenile and adult salmonids

4. All paved traffic areas will be kept free from sediment accumulations by daily sweeping and washing.

5. Turbidity will be monitored at the construction site, at flagged sampling stations 50 feet upstream from the excavation area and 250 feet downstream from the excavation area to facilitate compliance with limits on turbidity set forth in Washington Department of Ecology Order No. DE 97WQ-007 (February 24, 1997), and at a flagged sampling station located one-quarter mile downstream from the site.

Construction Sequence: Toe and Bank Repair

1. Stake limits of construction area at site.

2. Trench silt fence into riverbank slope, at lower limit of construction bench.

3. Place pea gravel berm to anchor silt fence into trench.

4. Excavate upper ten vertical feet of existing levee fill to create construction equipment access bench landward of silt fence.

5. Stockpile excavated materials landward of existing levee downstream of project area, onto pea gravel stockpile storage base.

6. Shape ramps to access equipment bench from existing levee crest upstream and downstream of bench area.

7. Starting at downstream project limits, construct toe repairs in fifteen foot long (maximum) increments, as follows:

8. Lay willow shoots flat against slope and anchor in place with sandbags to prevent damage from equipment. Prune shoots only if needed to prevent breakage.

9. Install floating turbidity curtain.

10. Operating from the temporary construction bench using a PC-330 excavator, excavate localized pockets of failed or displaced toe materials to accommodate large (four- to six-man) toe rocks.

11. Immediately place six inches of crushed railroad ballast bedding over exposed silts and sands.

12. Place eight inches of quarry spalls over ballast for additional bedding.

13. Place one foot of light-loose riprap over quarry spalls for additional bedding.

14. Secure one-inch diameter anchor chain onto large (four-to-six-foot diameter) rock, using drill holes from quarry.

15. Set four to six foot diameter toe rocks into bankline and wedge into place with additional large rock and heavy-loose riprap. Alternate every other toe rock with anchor rock secured to chain. Pack top edge of rock toe with quarry spalls and railroad ballast to match existing bankline.

16. Gently lower LWD pieces (with rootwads attached) into the water parallel to the bank and secure them to the toe rock anchor chains as shown on the project drawings. Secure logs to anchor chains, starting at the downstream end and proceeding upstream. Overlap cut log ends riverward of the next rootwad protruding downstream and secure overlapped logs to each other with additional one-inch diameter anchor chain. To the maximum extent possible, anchoring of the LWD should seek to secure the logs as fully below the OHWM as possible, while minimizing the potential for individual logs to float up, onto the bankline, during flood events. Precise placement of individual LWD pieces will be accomplished under the supervision of the project engineer and the Senior Ecologist.

17. Repeat in next upstream increment to end of repair project area.

18. Install additional native willow and dogwood cuttings to repair any incidental disturbance of existing willow layers (installed in 1996).

Construction Sequence; Levee Crest Reconstruction

1. Replace stockpiled levee fill materials onto bench area to reconstruct levee prism to original height. Compact in eight inch lifts to 95 % maximum density at optimal moisture content.

2. Bring the levee slope face as close as possible to finish grade and mulch with straw on a daily basis as needed during any anticipated periods of rainy weather. Finish grading upper bank slope.

3. Reserve one to three feet of fill depth along both landward and riverward levee face for placement of planting soil. Place soil as shown on cross-section drawing. Dress finished levee face slope with one to three feet of an approved planting soil mix (≥ 20% Groco) as needed to support riparian vegetation establishment and hydroseed immediately following completion.

4. Stake slope areas subject to winter inundation with coir fabric over the completed hydroseed cover as needed to prevent winter erosion.

5. Hydroseed any remaining disturbed soil surfaces following completion of all construction. activities.

6. Remove turbidity curtain.

7. Water plants and grass seed as needed, twice a week minimum, until the onset of fall rains.

8. Once grass cover is established and thriving, remove silt fence, hand smooth trench area to distribute pea gravel over disturbed soils along length of trench, hand seed, and cover with straw mulch.

9. Add additional plantings to willow layers above toe during the following plant dormancy season (October1 through February 28).

10. Plant middle and upper slope areas with potted upland native shrubs during the following plant dormancy season (October 1 through February 28) in accordance with planting plan and plant schedule shown on the project drawings.

Equipment Used: PC 330 track hoe, D-3 bulldozer, 10 CY dump trucks, flatbed willow and watering trucks, pickup trucks, 1 ton flatbed trucks, 30' bed trash hauler, portable water pump and/or water truck, hydroseed truck, vibratory roller/compactor.

Long Term ESC Monitoring

All stabilized slope areas will be monitored for signs of erosion during wet winter months and immediately repaired. Repairs can include straw mulching, straw mulch packing of incipient rills, gravel patching of incised rills, additional placement of topsoil, additional hand- and/or hydroseeding, placement of washed rock filter berms, and localized placement of additional silt fencing. The goal is to maintain a vigorous establishment of dense, deeply rooted erosion control grasses and native riparian vegetation on all disturbed slope areas at all times.

Long Term Project Monitoring

For details on long term monitoring of structural integrity, riparian habitat, instream habitat and fish habitat utilization monitoring, please refer to the monitoring plan in Chapter 11.

3.6 Construction Schedule

Inwater portions of this project are proposed to occur over a four week period between June 15 and August 15 (or as otherwise authorized by permit conditions), sometime between 2001 and 2003 which coincides with the anticipated window for instream construction to be established by the WDFW Area Habitat Biologist. However this window is subject to change due to the chinook and bull trout listings. Out-of-water work may continue until October. Potted plant installation will take place during the ensuing plant dormancy season (October 1 through February 28).

4 PROJECT DESCRIPTION AND SITE SPECIFIC INFORMATION, DESIMONE LEVEE REPAIR

4.1 Project Location

The vicinity of the Desimone Levee Repair is shown in Figure 4.1, and the project area and project site are shown in Figure 4.2. The project site is between RM 15.4 and 15.6 on the right bank of the Green River within the City of Tukwila. The area lies in the Northwest and Northeast and Southwest Quarters of Section 35 of Township 23, Range 4 East Meridian, in the vicinity of the west termini of Todd Blvd. and S. Glacier St.

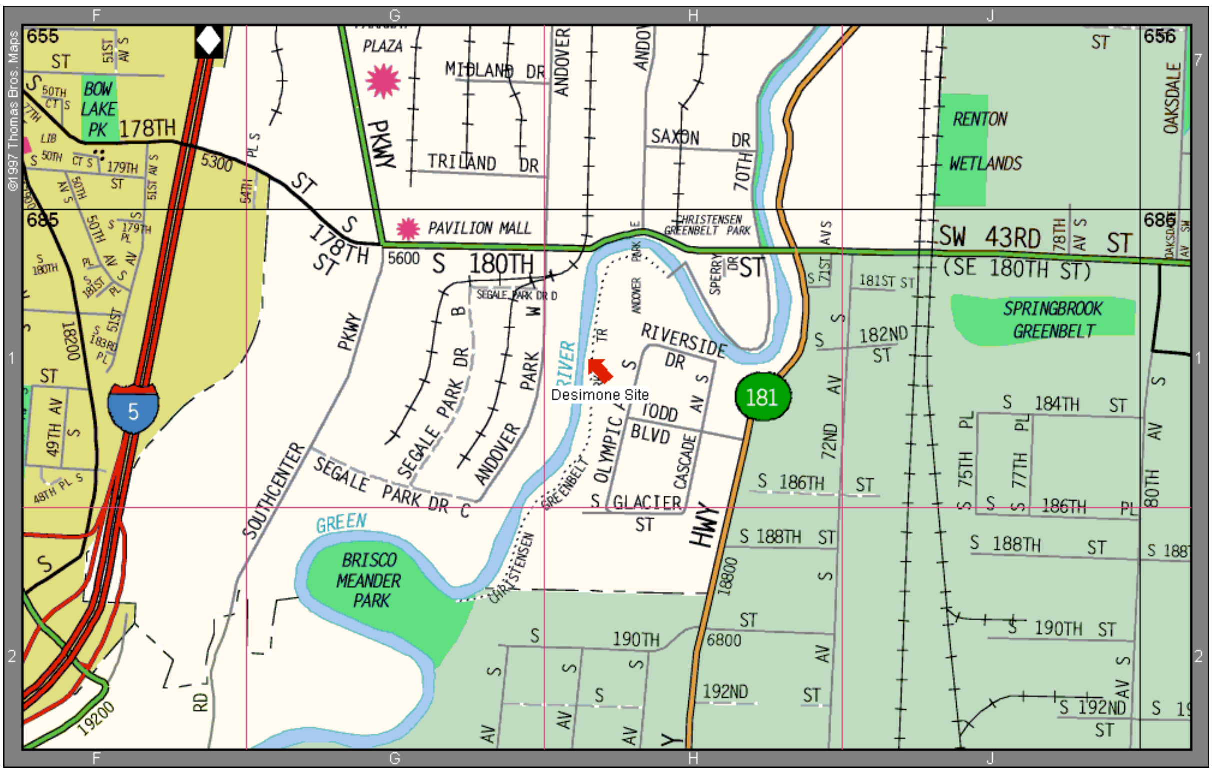

Figure 4. 1 Desimone Levee Repair Vicinity Map

4.2 Site Specific Conditions

The Desimone Levee Repair site is a small segment of the 2.46 mile long Desimone/Briscoe Levee system built in 1974 by King County. The 4,000 foot Desimone Levee reach (from S. 180th Street to the Tukwila/Kent boundary line) examined for this report lies within land presently occupied almost entirely by commercial warehouses, light industrial factories and office buildings. The riparian area immediately upstream from the project site is occupied by Briscoe Park within the City of Kent.

The total channel width (facility top width) within the project reach ranges from 100 to 140 feet, and the ordinary high water mark (OHWM) width ranges from 60 to 70 feet. The planform of the river within the project reach is meandering; the facility repair site is mostly straight, but a slight inside bend is present near the upstream end of the project site. The project reach and adjacent reaches upstream and downstream show the effects of extreme channelization, bank hardening and floodplain filling to create commercial and industrial buildings, streets, parking lots, a railroad line, a bicycle trail and other public and private infrastructure. Hydraulic controls at this site include levee confinement per se (including the Segale Levee on the opposite bank) and operation of the Howard Hanson Dam upstream by the USACE.

The streambed of this regime channel is composed of organic materials, silt and sand; no gravels, boulders or bedrock are present except for rock materials that have sloughed from the facility toe into the channel. The facility is within a sediment accumulation zone as evidenced by accumulation of sediment along most of the toe length within the project reach. At the same time, it appears that erosion is episodic at this site, as evidenced by toe erosion along other portions of the facility. Shifting mud and silt along with some sand deposits on the midslope area are involved in localized slumping along portions of the facility. There is a narrow but noticeable bench at the inside bend near the upstream end of the project site.

A survey of LWD abundance conducted in September 2000 revealed that 23 pieces of old, partially decomposed LWD exist between center of the channel and the toe of the levee. In addition, 11 relict pilings are present along the toe of the facility.

Over 90 percent of the riparian vegetation covering the riverward levee slope consists of reed canarygrass (*Phalaris arundinacea*) and Himalayan blackberry (*Rubus discolor*), with lesser amounts of big leaf maple (*Acre macrophyllum*) saplings, willows (*Salix* spp.), morning glory (*Convulvus arvensis*), snowberry (*Symphoricarpos alba*), and Scot's broom (*Cytisus scoparius*). A single small clump of purple loosestrife (*Lythrum salicaria*) was observed during a survey in September 2000. The lack of overhanging vegetation and tree canopy on the riverward side of the levee leaves inhabitants of the stream exposed to undampened high velocity flows along the bank line, as well as predators and warm water temperatures. Some of the felled Lombardy poplars (*Trichocarpa nigra*) stored on the low bench constructed during Phase 2 of this project have sprouted suckers since they have placed there. There is little in the way of riparian habitat niches for terrestrial wildlife utilizing the river corridor, although a variety of passerine birds species have been observed at various times using the existing riparian vegetation, and a family of beavers was observed foraging on Lombardy poplar shoots by King County flood staff conducting a midnight flood inspection during a flood in 1999.

A 12 foot wide asphalt bicycle/pedestrian trail occupies the 16 to 20 foot wide levee crest. Prior to completion of earlier phases of this project in 1998 and 1998, the backslope vegetation consisted of a row of the above-mentioned mature Lombardy poplars at the upstream end of the project, several mature fruit trees (*Prunus* cultivars) near the downstream end of the project, and patches of understory consisting of blackberries, giant knotweed (*Polygonum subspicatum*) and reed canarygrass. A portion of the backslope set back in 1998 adjacent to a new commercial warehouse building built concurrent with Phase 1 of this project was planted with native shrubs including red-osier dogwood (*Cornus stolonifera*), Pacific ninebark (*Physocarpus capitatus*) wild rose (*Rosa* spp.) as well as non-native tree cultivars. The backslope segment upstream of this new building was planted the same mixture of native riparian shrubs as those listed in the plant schedule for this proposed project, which constitutes Phase 3 of the overall project initiated in 1998 (see Sections 4.3 and 4.5 for a detailed description of work completed in Phases 1 and 2).

Habitat and Fish Utilization Surveys

Riparian Habitat: On October 18, 1999 King County and USFWS staff collected habitat data and surveyed fish utilization within a 40 meter length of the project reach, and a 40 meter control reach[1] on the opposite bank just upstream from the proposed Segale Levee repair project (see data forms in Appendix E). The river discharge that day was 386 cfs at Auburn. The average flow in the project reach was 0.12 feet/second, but it was not measured in the control reach. Little native riparian vegetation was present along the waterward slope of both the project and control reaches due to historic vegetation management practices, including maintenance of these levees in an oversteepened condition. Riparian tree canopy was absent along both the project and control reaches. Most of the lower bank riparian vegetation in the project reach consisted of blackberries and reed canarygrass. The riparian vegetation along the lower bank of the control reach consisted of willows planted during the 1996 repair of the Segale Levee, but these willows were not large enough to provide overhanging vegetation. The low bench excavated within the project reach during Phase 2 of the Desimone Levee repair remains largely unvegetated, although some small saplings have sprouted underneath the poplars stored on the bench pending their placement in the channel during Phase 3 of this project. The backslope of the project reach was planted with native shrubs (and trees alongside a new 480 foot long factory building) during the 1999-2000 plant dormancy season, but these plants were still too small to function as riparian habitat.

Instream Habitat: Within both the project and control reaches, 40-meter long habitat units were identified, characterized as narrow, relatively shallow lateral scour pools with slow-moving water. Instream cover throughout the 40-meter project and control reaches consisted of toe rock boulders. The substrate in the project reach consisted of minimally embedded silt and sand, but it was moderately embedded in the control reach. The overall habitat complexity in the project reach was judged to be moderate because of the cover afforded by the toe rock boulders. The overall habitat complexity in the control reach was judged to be low, perhaps because the boulders in thie control reach are smaller than those in the project reach.

Fish Survey: No fish were seen in either the project or control reaches.

Future Surveys: Additional habitat and fish surveys are planned starting in February 2001

4.3 Proposed Action

The primary goals of the Desimone Levee Repair project are to (1) stabilize a segment of the Desimone levee where several saturation slump failures are present, and (2) improve habitat for salmonids and terrestrial wildlife.

The current project is the third phase of a project that was begun in 1998, but divided into three different phases for permitting and construction. Phase 1 was permitted in 1998 and constructed between September and November of 1998. This phase entailed construction of 700 lineal feet of newly set back levee crest and back slope along a portion of the full 1300 lineal feet project site.

[1] This same 40 meter control reach was also designated as the control reach for the Segale Levee repair project on the opposite bank.

Phase 2 was permitted in 1999 and constructed between September and mid-October, 1999. This phase involved completion of the remaining 600 lineal feet of the levee crest setback, paving of the newly set back crest trail, removal of invasive blackberries (*Rubus discolor*) and reed canarygrass (*Phalaris arundinacea*) from the existing front slope of levee, and excavation of a 20 foot wide bench approximately 10 feet above the OHWM along the full 1300 lineal feet of the project . Phase 2 also included the removal of up to 14 mature Lombardy poplars near the upstream and downstream ends of the site, eight ornamental fruit trees from near the downstream end of the site, and their temporary staging on the surface of the newly excavated low bench. Immediately following completion of this work, erosion control hydroseed was applied to all disturbed surfaces, and revegetation with native shrubs and trees occurred during the 1999-2000 plant dormancy season on the newly set back levee backslope and front slope above the bench.

Phase 3, currently proposed for construction in the mid-summer sometime between 2001 and 2003, will include (1) instream installation of 49 pieces of coniferous LWD (all but three of which will have intact rootwads) parallel to the bank, anchored to large toe rock installed within the lower bankline and/or concrete deadmen completely buried within the low bench excavated in Phase 2; (2) placement of the 14 previously staged poplars parallel to the bankline alongside the coniferous logs to improve instream habitat for salmonids; (3) installation of native willow and red-osier live brush layers in the lower bank downslope from the low bench; and, (4) during the ensuing plant dormancy season (October 1 through February 28), revegetation of the bench and other disturbed surfaces that were not previously revegetated in Phases 1 and 2 with native trees and shrubs.

Anticipated Future Site Characteristics

Although existing buildings and other infrastructure severely limit the extent to which the levee can be set back landward from its existing configuration, the likely geomorphic response to the modest setback design proposed in Phase 3 of this project will be enhanced sediment deposition on the setback bench, and reduced toe erosion and bank slumping. The bank resloping previously accomplished in Phase 2 of this project, coupled with the Phase 3 introduction of LWD and full revegetation will increase the structural stability of the facility, and also provide hydraulic refuge and overhanging cover for fish. In addition, water quality in the project reach will likely improve somewhat due to a decrease in erosive flows and slumping, and an increase in deposition of suspended sediments and the biofiltering effects of native riparian vegetation as it matures over time.

The expected net results of levee reconfigurations conducted in all three Phases are (1) improved structural stability resulting from reduction of the facility slope from its previously oversteepened 1.4H:1V angle to a more gentle overall slope angle of 2H:1V; (2) improved flood conveyance capacity and lower water velocities due to widening the cross-sectional area of the channel within the project reach; (3) improved salmonid habitat (escape cover, hydraulic refuge and feeding opportunities) afforded by installation of coniferous and deciduous LWD within the toe of the facility and deciduous LWD parallel to the facility toe; and (4) improved riparian habitat and water quality due to replacement of the previous vegetative biculture of reed canarygrass and blackberries with native riparian trees and woody shrubs.

4.4 Purpose and Need

The purpose of this levee repair is to (1) prevent channel migration and contain floodwaters within highly urbanized areas of Tukwila, Renton and Kent including the Southcenter South Business Park and other highly urbanized lands adjoining SR-181 (West Valley Highway) and extending east to the valley wall and north to I-405, and (2) locally improve water quality along with instream and riparian habitat.

4.5 Construction Activities

All construction activities have been and will continue to be performed subject to applicable federal, state, and county permit requirements and conditions, with the exception that current federal standards calling for wholesale devegetation of PL 84-99 non-federal levees will not be adhered to.

Desimone Levee Repair Phase 1 (completed in 1998):

1. Temporary access ramps were excavated from the top of bank at the upstream and downstream ends of the project segment into the backslope area of the levee between the existing asphalt trail surface and the riverward footprint of a new commercial building that was concurrently being constructed. The initially proposed building design was modified to accommodate the setback levee configuration.

2. A three by five foot trench was excavated at the landward edge of the new setback levee slope toe, and backfilled with two-inch angular rock over filter gravel to enable suitable drainage of any seepage that might accumulate near the toe of the newly set back levee backslope toe during future floods.

3. Clean, well graded soil was placed incrementally between the existing toe of the levee backslope and the new toe drain to create the newly set back levee backslope. Imported fill soils included ledge rock screenings from the Enumclaw quarry and recycled soils from the King County Roads Division stockpile in Renton. The final layer (one to three feet thick) was composed of Groco-amended planting soil (also from recycled stockpiles in Renton) to promote healthy growth of newly planted riparian shrubs.

4. All disturbed soil surfaces were immediately hydroseeded following the above work.

5. The newly set back levee back slope was planted with potted red-osier dogwood (*Cornus stolonifera*), Pacific ninebark (*Physocarpus capitatus*), salmonberry (*Rubus spectabilis*), thimbleberry, (*Rubus parviflorum*) and snowberry (*Symphoricarpos alba*) during the 1998-99 dormant season. The adjacent landowner planted a mixture of non-native trees and shubs during this same time period beyond the landward levee toe.

Equipment Used: PC330 and PC 220 track hoes, D-6 bulldozer, 10 CY dump trucks, pickup trucks, 1 ton flatbed trucks, 30' bed, hydroseed truck, vibratory roller/compactor.

Desimone Levee Repair Phase 2 (completed in 1999):

1. The following were brought to the site and staged on a daily basis as needed:
- Straw bales for slope mulching
- Silt fencing for perimeter siltation control
- Crushed or washed rock for control of soil pumping on exposed soils in heavy traffic areas
- 2-1/2 inch minus crushed rock for construction ramps
- 1-1/4 inch minus crushed rock for soil lifts
- 5/8 inch minus crushed rock for staging areas and road shoulders

- washed pea gravel for filter berms and silt fence installations
- Hand brooms, street sweepers, and wash trucks for control of sediments on paved traffic surfaces

2. The Phase 1 setback area was extended upstream and downstream for the full project length in the same manner described above. An existing fence and portions of an existing asphalt-paved parking lot were moved up to 16 feet landward in the southerly portion of the project site to set back the levee. Levee fill soils consisting of screenings were imported from the Enumclaw quarry and the Lloyds Excavating gravel pit in Federal Way.

3. A silt fence was installed along the full 1,700 feet of the project site 10 feet above the OHWM. The fence was keyed into place with a one foot high by two feet wide filter berm composed of pea gravel.

4. The failure area on the front side of the existing levee over the full length of the project site was excavated down to approximately 10 feet above the OHWM. The oversteepened levee slope was excavated back to a 2H:1V angle, leaving a 20 foot wide bench approximately 10 feet above the OHWM elevation. The excavated material was exported to an approved disposal site (Pacific Topsoil in Kent).

5. Semi-mature poplars removed from a portion of the backslope area prior to placement of fill for the newly set back levee crest and back slope were laid horizontally on the newly-excavated low bench with their rootwads facing upstream. These trees were temporarily anchored with deck-lashing chain to a series of large, predrilled quarry rocks which were also placed temporarily on the low bench for later use as toe rock LWD anchors in Phase 3.

6. All disturbed soil surfaces were hand seeded and straw mulched during the work. Coir fabric was staked to lower slope areas above the bench. Finally, all these surfaces were hydroseeded immediately following completion of the above work.

7. The newly set back slope and front slope will be planted with native shrubs during the 1999-2000 dormant season.

Equipment Used: PC 225, 230 and 330 track hoes, 10 CY dump trucks, 18 CY belly dump trucks, asphalt paving equipment, pickup trucks, 1 ton flatbed trucks, 30' bed trash hauler, hydroseed truck, water truck, vibratory roller-compactor and D6 bulldozer.

Proposed Desimone Levee Repair Phase 3 (inwater work to be completed between June 15 and August 15, 2001-2003)

<u>Temporary Erosion and Sediment Control (TESC)</u>

1. The following will be brought to the site and staged on a daily basis as needed:
   - Straw bales for slope mulching
   - Silt fencing for perimeter siltation control
   - Crushed or washed rock for control of soil pumping on exposed soils in heavy traffic areas
   - 5/8 inch minus crushed rock for staging areas and road shoulders
   - Pea gravel for filter berms and silt fence installations

- Hand brooms, street sweepers, and wash trucks for control of sediments on paved traffic surfaces.

2. An undisturbed band of existing vegetation will be left intact along the waterline until excavation of failed or damaged toe buttress areas for installation of crushed rock bedding, toe rock, LWD anchor rocks, and LWD.

3. A turbidity curtain (see Figure 10.1 and Table 10.5) will be installed at the site during prior to in-water construction.

4. All in-water construction will occur between June 15 and August 15 (or as otherwise authorized by permit conditions), sometime between 2001 and 2003 (or as otherwise authored by permit conditions), to avoid extended periods of rainy weather and high river discharge, and to coincide with the period of minimum habitat utilization by juvenile and adult salmonids.

5. All paved traffic areas will be kept free from sediment accumulations by daily sweeping and washing.

6. Turbidity will be monitored at the construction site, at flagged sampling stations 50 feet upstream from the excavation area and 250 feet downstream from the excavation area to facilitate compliance with limits on turbidity set forth in Washington Department of Ecology Order No. DE 97WQ-007 (February 24, 1997), and at a flagged sampling station located one-quarter mile downstream from the site.

Construction Sequence; Toe and Bank Repair

1. Stake limits of construction area at site.

2. Close the trail to recreational traffic during project construction.

3. Shape ramps to access bench from existing levee crest upstream and downstream of bench area.

4. Operating from the levee bench, detach the LWD rock anchor chains from the poplars previously staged on the low bench.

5. Starting at the downstream project limits, install the floating turbidity curtain in 175 foot-long increments to isolate the instream work area(s) from the flowing stream.

6. Starting at downstream project limits, construct toe repairs in fifteen foot long (maximum) increments, as follows:

7. Starting at the downstream end of the project, clear and grub existing blackberries and reed canarygrass from the lower bank slope, above the OHWM, in 15 foot increments. Export these plant and soil materials to an approved disposal location (Pacific Topsoil site in Kent or King County Roads Division soil recycling center in Renton).

8. Excavate existing failed levee rip-rap and unsuitable subgrade materials from the lower embankment slopes, above the water surface elevation, in the same 15 foot increments. Export

these materials to an approved disposal location (Pacific Topsoil site in Kent or King County Roads Division soil recycling center in Renton).

9. Excavate failed or damaged toe buttress areas and unsuitable subgrade materials from below the water surface elevation for placement of new crushed rock bedding, toe rock, and LWD anchor rocks, in the same 15 foot increments. Working from the embankment side toward the water's edge, leave an intact earthen "plug" at the riverward edge of the toe rock and LWD anchor rock excavation area until the moment of actual toe buttress bedding and rock placement in order to minimize turbidity.

10. Excavate and remove the earthen "plug" from along the water's edge, completing the excavation to depth as rapidly as possible. Immediately place 2-1/4" crushed railroad ballast and quarry spalls to stabilize the exposed riverbed and embankment soils, and to provide suitable bedding conditions for placement of toe and LWD anchor rock. Complete this work within the same 15 foot increments.

11. Place rock LWD anchors within the prepared toe buttress bedding area at a 25 foot spacing, with anchor chains already attached to quarry holes drilled in the rock. Place additional toe buttress rocks in place to firmly secure the LWD anchors in place, and to secure the entire toe buttress against undercutting erosion, working within the same 15 foot increments as above. Level the top edge of the rock toe buttress at a finished elevation approximately one foot above the OHWM, using light loose rip-rap, 2-1/2" crushed ballast, and 1-1/4" crushed gravel to provide a secure base for subsequent soil lifts and plantings.

12. Using the trackhoe bucket, gently place the poplars and additional coniferous LWD into the water column, securing them along the bankline to the anchor rock with the chain attachments, and to each other , starting at the downstream end and proceeding upstream. Overlap cut log ends riverward of the next rootwad protruding downstream and secure overlapped logs to each other with additional one-inch diameter anchor chain. The LWD should overlap in a downstream direction as shown on the plan sheets. To the maximum extent, anchoring of the LWD should secure the logs as far below the OHWM as practical, while minimizing the potential for individual logs to float up, and becomes lodged on the bankline, during flood events. Precise placement of individual LWD pieces will be accomplished under the supervision of the project engineer and the Senior Ecologist.

13. Proceed as specified above in 15 foot increments upstream, relocating the floating turbidity curtain as needed for subsequent portions of the instream work, to the end of the project repair reach.

14. Remove turbidity curtain.

Levee slope reconstruction

1. Following completion of all instream toe buttress construction and LWD placement, place a 3-inch lift of crushed quarry screenings the full length of the toe buttress along the top edge of the newly placed rock. Seal all underlying voids and to create a secure base for subsequent placement of soil lifts and planting layers. Make sure the top surface of the screenings is located at a minimum of six inches above the OHWM elevation.

2. Place an 8-inch layer of Groco-amended planting soil (≥ 20% Groco content) along the full length of the bench adjoining the riverbank within the project area, extending for a minimum of eight feet in width. Place a layer of live willow and dogwood cuttings onto the planting soil layer as shown on the cross section drawings. The cuttings will up to 10 feet in length in order to extend the width of the prepared soil lifts. Place additional potted native riparian shrub and tree species into the exposed edge of the soil lift as specified in the planting schedule. Butt ends of the cuttings can be up to four inches in diameter; exposed ends of the cuttings will extend no more than one foot riverward from the finished slope. Cover the layer of cuttings and potted plants with an additional 6 to 8 inches of planting soil and compact lightly with a single pass of the trackhoe or bulldozer tracks. Once installed in this manner, each layer of plantings will be embedded in a one foot minimum thickness of Groco-amended planting soil.

3. Import selected levee fill soils to the site and compact them in eight inch lifts to form fill layers between the layers of plantings. Each fill layer will be composed of three compacted soil lifts, extending the full length of the riverbank within the project area. Each finished fill layer will be wrapped with coir fabric for erosion protection.

4. Selected fill soils will be supplemented in lifts with crushed rock materials as noted above during periods of rainfall to provide for adequate compaction and to prevent pumping of mud in areas subject to equipment passage and truck traffic.

5. Alternate planting layers and coir wrapped fill and reconstruct lower embankment slopes to finished grade as shown on the cross section drawings and plan sheet.

6. The lower embankment slope lifts will be brought as close as possible to finished grade and mulched with straw on a daily basis as needed during any anticipated periods of rainy weather.

7. Hydroseed any remaining disturbed soil surfaces immediately following completion of all construction activities.

8. Stake slope areas subject to winter inundation with coir fabric over the completed hydroseed cover as needed to prevent winter erosion.

9. Plant middle and upper slope areas with additional potted native shrubs during the following plant dormancy season (October 1 through February 28) in accordance with planting plan and plant schedule shown on the project drawings.

10. Water plants and grass seed as needed, twice a week minimum, until the onset of fall rains.

Equipment Used: PC 225, 230 and 330 track hoes, 10 CY dump trucks, 18 CY belly dump trucks, pickup trucks, 1 ton flatbed trucks, 30' bed trash hauler, hydroseed truck, water truck, and D6 bulldozer.

Long Term ESC Monitoring

All stabilized slope areas will be monitored for signs of erosion during wet winter months and immediately repaired. Repairs can include straw mulching, straw mulch packing of incipient rills, gravel patching of incised rills, additional placement of topsoil, additional hand- and/or hydroseeding, additional installation of willow and dogwood live cuttings and/or potted native riparian shrubs and trees, placement of washed rock filter berms, and localized placement of additional silt fencing. The goal is to maintain a vigorous establishment of dense, deeply rooted erosion control grasses and native riparian vegetation on all disturbed slope areas at all times.

Long Term Project Monitoring

For details on long term monitoring of structural integrity, riparian habitat, instream habitat and fish habitat utilization monitoring, please refer to the monitoring plan in Chapter 11.

4.6 Construction Schedule

The project consists of three phases:

- Phase 1 was completed in November 1998.
- Phase 2 was completed in October 1999.
- Inwater work in Phase 3 is proposed to occur between June 15 and August 15 (or as otherwise authorized by permit conditions), sometime between 2001 and 2003, which coincides with the likely window for instream construction to be established by the WDFW Area Habitat Biologist. Out-of-water work may proceed until October 15. All potted plant installation will take place during the ensuing plant dormancy (October 1 through February 28).

5 PROJECT DESCRIPTION AND SITE SPECIFIC INFORMATION, BOEING LEVEE REPAIR

5.1 Project Location

The vicinity of the Boeing Levee Repair is shown in Figure 5.1, and the project area and project site are shown in Figure 5.2. This project site is at RM 17.7 on the right bank of the Green River within the City of Kent. The site lies in the Southwest Quarter of Section 2 of Township 22, Range 5 East Meridian, approximately one-quarter mile downstream from the S. 212th St. bridge.

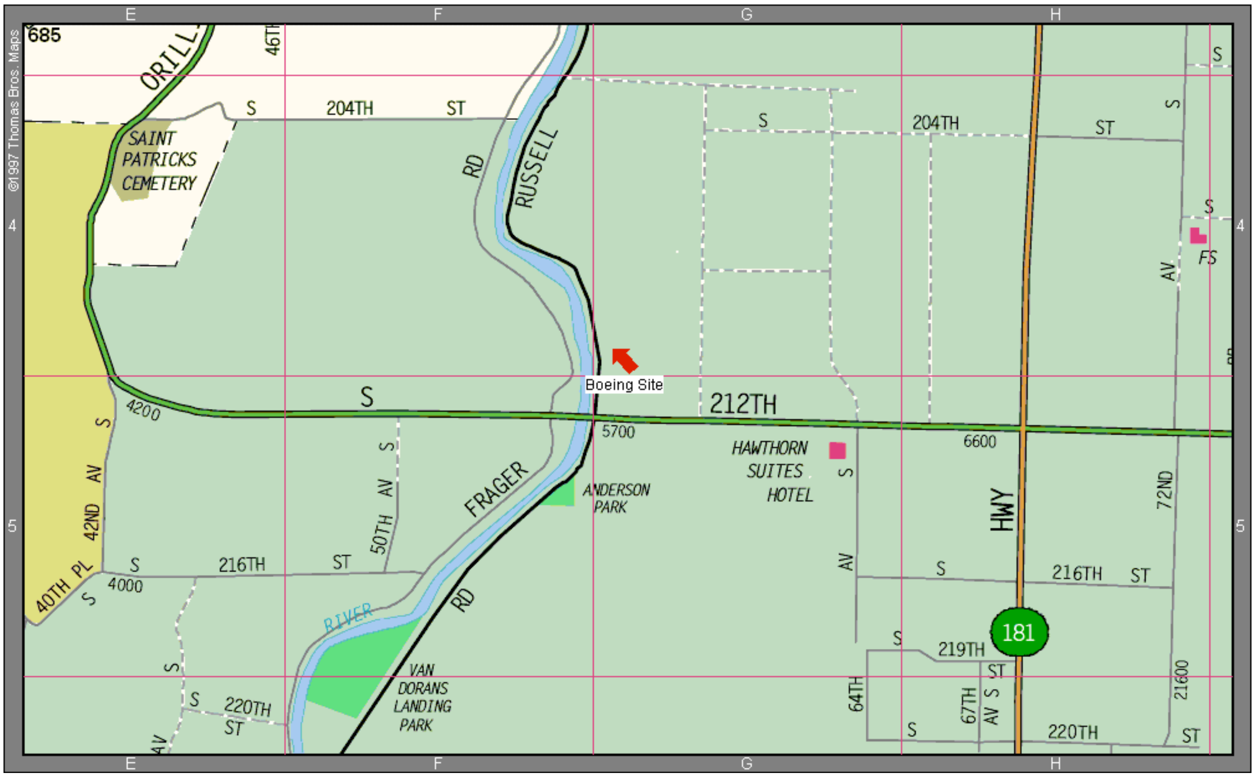

Figure 5.1 Boeing Levee Repair Vicinity Map

5.2 Site-Specific Conditions

A slope failure extends from near the top of bank adjoining the road shoulder to below the OHWM along 90 lineal feet of the river bank. A slight channel constriction exists in the vicinity of the old S. 212th St. bridge crossing just downstream from the existing bridge. As flow exits this constriction, it enters a deep expansion pool and then begins a well defined curve to the left. This moves the thalweg into the right bank in the vicinity of the bank failure which will be addressed by this repair project. At the same time, a relatively indurated, buff-colored silty clay unit creates a well-defined, locally undercut shelf exposed at and immediately below the OHWM over several hundred feet upstream, and continuing downstream from this bank failure location. Based on inspection of previous repairs in failed slope materials overlying this buff clay shelf, there is commonly present a soft, saturated blue clay with inclusions of very soft peat. This unit appears to be associated with prehistoric slough and overbank channel wetland infill deposits within the historic floodplain and exhibits year around seepage and spring activity. Drainage through this unit is impeded both by the denser blue clay and especially by the underlying buff clay units. Overlying sands associated with historic White River discharge and more recent silty deposits from Green River flood discharge become highly saturated during prolonged flood storage releases from the Eagle Gorge Reservoir at HHD. Together with elevated valley floor winter groundwater levels affecting these units at shallow depths overlying the above-mentioned clay deposits, this saturation of river embankment soils has resulted in number slumping failures at this site following drawdown of river stage after evacuation of flood impoundments from the reservoir .

As shown in Figure 5.2, the bank failure which is the subject of this repair is the latest in a series of five such slumping failures affecting a one-quarter mile segment of the right bank downstream from the S. 212th St. bridge. The present repair immediately adjoins the downstream end of a previous bioengineering repair constructed by the City of Kent and King County in 1991. It is also adjacent to a 4,000 foot long project completed during the summer and early fall of 2000 between the S. 212th and S. 200th Street bridges where Russell Road, which effectively functioned as a levee, was abandoned by the City of Kent and replaced by a narrower, asphalt-paved segment of the Green River trail set back 200 feet landward from the OHWM of the river[1].

Habitat and Fish Utilization Surveys

Riparian Habitat: On October 18, 1999 King County and USFWS staff collected habitat data and surveyed fish utilization within a 30 meter length of the project reach, and a 65 meter control reach[2] just upstream from the Meeker Street foot bridge on the left bank upstream from the proposed Narita Levee repair project (see data forms in Appendix E). The river discharge that day was 386 cfs at Auburn. The average flow in the project reach was 1.12 feet/second. Average flow in the control reach was 0.5 feet/second in the lateral scour pool, and 0.3 feet/second in the backwater habitat. Little native riparian vegetation was present along the waterward slope of the facilities in both the project and control reaches due to historic vegetation management practices, including maintenance of the facilities in an oversteepened condition. Riparian cover was absent along the project reach, but was present along 10 percent of the control reach. Most of the lower bank riparian vegetation in both the project and control reaches consisted of blackberries and reed canarygrass. Ninety percent of the bankline along the project reach had overhanging vegetation, but no overhanging vegetation was present along the control reach. The upper bank of both the project and control reaches consisted mainly of blackberries.

Instream Habitat: Within both the project and control reaches, the primary habitat was characterized as a narrow, relatively shallow lateral scour pool. A single secondary habitat was identified within the project reach, characterized as shallow, slow-moving water. Two secondary habitats were identified within the control reach: a 54 meter long stretch of shallow, slow-moving water, and an 11 meter segment of backwater. Instream cover in the project reach consisted of vegetation along 30 meters of the survey reach, and woody debris along half a meter of the survey reach. Instream cover in the control reach consisted entirely of riprap. The substrate in the project reach consisted of embedded coarse sand. The substrate in the control reach consisted of unembedded coarse sand. The overall habitat complexity in the project reach was judged to be moderate because of the cover

[1] The aerial photo in Figure 5.2 predates the levee setback project constructed in 2000.
[2] This same 65 meter control reach was also designated as the control reach for the Boeing and Narita levee repair projects.

afforded by the overhanging vegetation, and small amount of LWD. The overall habitat complexity in the control reach was judged to be moderate because the presence of a backwater eddy and indented riprap.

Fish Survey: No fish were seen in either the project or control reaches.

Future Surveys: Additional habitat and fish surveys are planned starting in February 2001.

5.3 Proposed Action

Failed slope materials will be excavated to form two benches within a flatter slope angle, as shown in the project drawings in Appendix C. A rock slope drain will be installed adjacent to the seeps and springs. A rock toe buttress will be keyed in, and 16 pieces of LWD will be installed along the bankline, including eight logs embedded within the toe and eight logs chained parallel to the bank. The slope immediately above the OHWM will be reconstructed with native willow and dogwood cuttings, and other native riparian trees and shrubs will be layered in topsoil between lifts of well graded sand and gravel fill, wrapped with coir fabric for erosion protection. The lower and upper bench will be revegetated with native trees and shrubs.

5.4 Purpose and Need

The newly relocated Boeing Levee provides freeboard for flood containinment protecting eastern portions of the Green River Valley in the vicinity of the Boeing Aerospace Center. The project purpose is to decrease the slope of the currently oversteepened riverbank to a flatter and more stable angle in order to eliminate chronic sloughing of fine sediment into the river, and to improve instream and riparian habitat at this location.

5.5 Construction Activities

Temporary Erosion and Sediment Control (TESC)

1. The following will be brought to the site and staged on a daily basis as needed:
   - Straw bales for slope mulching
   - Silt fencing for perimeter siltation control
   - Crushed or washed rock for control of soil pumping on exposed soils in heavy traffic areas
   - 5/8 inch minus crushed rock for staging areas and road shoulders
   - P~~p~~ea gravel for filter berms and silt fence installations
   - Hand brooms, street sweepers, and wash trucks for control of sediments on paved traffic surfaces

2. An undisturbed band of existing vegetation will be left intact along the waterline until excavation of failed or damaged toe buttress areas for installation of crushed rock bedding, toe rock, LWD anchor rocks, and LWD.

3. A turbidity curtain (see Figure 10.1 and Table 10.5) will be installed at the site prior to in-water construction.

~~A floating silt curtain will be kept present at the site at all times during construction and promptly installed into the water column to sequester any observed plumes of turbid water entering the water.~~

4. All in-water construction will occur between June 15 and August 15 (or as otherwise authorized by permit conditions), sometime between 2001 and 2003, to avoid extended periods of rainy weather and high river discharge, and to coincide with the period of minimum habitat utilization by juvenile and adult salmonids.

~~2.All inwater construction will occur before August 15, 2000, to avoid extended periods of rainy weather and high river discharge, and to coincide with the period of minimum habitat utilization by juvenile and adult salmonids.~~

5. All paved traffic areas will be kept free from sediment accumulations by daily sweeping and washing.

~~3.All paved traffic areas will be kept free from sediment accumulations by daily sweeping and washing.~~

~~4.~~6. Turbidity will be monitored at the construction site, at ~~a~~ flagged sampling stations 50 feet upstream from the excavation area and 250 feet downstream from the excavation area to facilitate compliance with limits on turbidity set forth in Washington Department of Ecology Order No. DE 97WQ-007 (February 24, 1997), and at a flagged sampling station located one-quarter mile downstream from the site.

Construction Sequence; Toe and Bank Repair

1. Stake limits of construction area at site.

2. Trench silt fence into riverbank slope, at lower limits of construction bench area, leaving an intact band of undisturbed vegetation downslope from the silt fence location, extending to the OHWM.

3. Place pea gravel berm to anchor silt fence into trench.

4. Excavate upper embankment slopes to create and shape ramps to access construction bench excavation area, from both upstream and downstream of bench area.

5. Operating from the upper bank and from the ramps as needed, excavate the construction bench, landward of the silt fence.

6. As excavation encounters saturated clay materials at depth, overexcavate these materials in ten to 15 foot long increments, including overexcavation of underlying soft clay and peat soils as needed to secure equipment access along the construction bench. Immediately backfill excavated areas with firm bearing crushed railroad ballast and quarry spall bedding materials to form a firm base for the trackhoe, trucks, and other construction equipment operating on the bench.

7. Place a minimum thickness of three feet of crushed railroad ballast to form a slope drain to capture and control any seepage present in the clay soil materials exposed in the excavated embankment cutslope or at depth, as shown on the cross section drawings in the project plans. A minimum thickness of three feet of crushed railroad ballast must be maintained at all times as a

surficial treatment of the exposed construction bench, landward of and at a minimum elevation of six inches lower than the silt fence installation.

8. Starting at the downstream project limits, install the floating turbidity curtain in 175-foot-long increments to isolate the instream work area(s) from the flowing stream.

9. Starting at downstream project limits, construct toe repairs in fifteen foot long (maximum) increments, as follows:

10. Starting at the downstream end of the project, clear and grub existing blackberries and reed canarygrass from the lower bank slope, above the OHWM, in 15 foot increments. Export these plant and soil materials to an approved disposal location (Pacific Topsoil site in Kent or King County Roads Division soil recycling center in Renton).

11. Excavate existing failed levee rip-rap and unsuitable subgrade materials from the lower embankment slopes, above the water surface elevation, in the same 15 foot increments. Export these materials to an approved disposal location (Pacific Topsoil site in Kent or King County Roads Division soil recycling center in Renton).

12. Excavate failed or damaged toe buttress areas and unsuitable subgrade materials from below the water surface elevation for placement of new crushed rock bedding, toe rock, and LWD anchor rocks, in the same 15 foot increment. Working from the embankment side toward the water's edge, leave an intact earthen "plug" at the riverward edge of the toe rock and LWD trench excavation area until the moment of actual LWD, toe buttress bedding and rock placement in order to minimize turbidity.

13. Excavate and remove the earthen "plug" from along the water's edge, completing the excavation to depth as rapidly as possible. Immediately place 2-1/4" crushed railroad ballast and quarry spalls to stabilize the exposed riverbed and embankment soils, and to provide suitable bedding conditions for placement of LWD and toe rock. Complete this work within the same 15 foot increments.

14. Place LWD within the prepared toe trench bedding area at a 15 foot spacing, as shown on the plan drawings. Place additional toe buttress rocks in place to firmly secure the LWD in place, and to secure the entire toe buttress against undercutting erosion, working within the same 15 foot increments as above. Level the top edge of the rock toe buttress at a finished elevation approximately one foot above the OHWM, using light loose rip-rap, 2-1/2" crushed ballast, and 1-1/4" crushed gravel to provide a secure base for subsequent soil lifts and plantings.

15. Using the trackhoe bucket, gently place the additional coniferous LWD into the water column, securing them along the bankline to the imbedded LWD with the chain attachments, and to each other, starting at the downstream end and proceeding upstream. Overlap cut log ends riverward of the next rootwad protruding downstream and secure overlapped logs to each other with additional one-inch diameter anchor chain. The LWD should overlap in a downstream direction as shown on the plan sheets. To the maximum extent, anchoring of the LWD should seek to secure the logs below the OHWM as fully as possible, while minimizing the potential for individual logs to float up, onto the bankline, during flood events. Precise placement of individual LWD pieces will be accomplished under the supervision of the project engineer and the Senior Ecologist.

16. Proceed as specified above in 15 foot increments upstream, relocating the floating turbidity curtain as needed for subsequent portions of the instream work, to the end of the project repair reach.

17. Remove turbidity curtain.

~~Excavate up to 10 vertical feet of the existing levee crest to provide a temporary construction bench for the excavator. Stockpile the excavated materials on the levee crest downstream for reuse following toe reconstruction.~~

~~2.Operating from the temporary construction bench using a PC-330 excavator, excavate localized pockets of failed or displaced toe materials to accommodate large (four- to six-man) toe rocks with pre-drilled holes to which log anchor chains have been secured.~~

~~3.Place quarry spalls and light-loose riprap bedding in excavated pockets to bed toe rocks.~~

~~4.Place the toe rocks in the excavated, bedded pockets.~~

~~5.Place light-loose riprap and quarry spalls to fill voids between and on top of toe rocks to approximately one foot above the OHWM.~~

~~Gently lower LWD (with rootwads attached) into the water parallel to the bank and secure them to the toe rock anchor chains as shown on the project drawings. Secure logs to anchor chains, starting at the downstream end and proceeding upstream in order to overlap cut log ends with the next rootwad protruding downstream.~~

~~7.Install native willow and dogwood cuttings to repair any incidental disturbance of existing willow layers (installed in 1996). Install willow and dogwood brush layers in the in the lower levee slope fill lifts. These brush layers will be composed of live native willows and/or dogwood cuttings of up to twelve feet in length. Butt ends of the cuttings can be up to four inches in diameter; exposed ends of the cuttings will extend no more than one foot from the finished slope.~~

~~Levee crest reconstruction:~~

~~1.Replace excavated levee crest in eight inch compacted lifts using previously stockpiled materials. Bring the levee slope face lifts as close as possible to finish grade and mulch with straw on a daily basis as needed during any anticipated periods of rainy weather. Finish grading upper bank slope.~~

~~2.Dress finished levee face slope with six to eight inches of an approved topsoil mix as needed to support riparian vegetation establishment and hydroseed. immediately following completion.~~

~~Stake lower slope and bench areas subject to winter inundation with coir fabric over the completed hydroseed cover as needed to prevent winter erosion.~~

~~Hydroseeded any remaining disturbed soil surfaces following completion of all construction activities.~~

~~**5.Plant middle and upper slope areas with potted upland native shrubs during the following plant dormancy season (October 1, 2000 through March 31, 2001) in accordance with planting plan and plant schedule shown on the project drawings.**~~

~~**Equipment Used: PC 330 track hoe, D-4 bulldozer, 10 CY dump trucks, flatbed willow and watering trucks, pickup trucks, 1 ton flatbed trucks, 30' bed trash hauler, portable water pump and/or water truck, hydroseed truck, vibratory roller/compactor.**~~

~~**Long Term ESC Monitoring: Post-construction ESC monitoring will be accomplished as follows:**~~

~~**All stabilized slope areas will be monitored for signs of erosion during wet winter months and immediately repaired. Repairs can include straw mulching, straw mulch packing of incipient rills, gravel patching of incised rills, additional placement of topsoil, additional hand- and/or hydroseeding, placement of washed rock filter berms, and localized placement of additional silt fencing. The goal is to maintain a vigorous establishment of dense, deeply rooted erosion control grasses and native riparian vegetation on all disturbed slope and bench areas at all times.**~~

Levee slope reconstruction

1. Following completion of all instream toe buttress construction and LWD placement, place a 3-inch lift of crushed quarry screenings the full length of the toe buttress along the top edge of the newly placed rock. Seal all underlying voids and to create a secure base for subsequent placement of soil lifts and planting layers. Make sure the top surface of the screenings is located at a minimum of six inches above the OHWM elevation.

2. Place an 8-inch layer of Groco-amended planting soil (≥20% Groco content) along the full length of the bench adjoining the riverbank within the project area, extending for a minimum of eight feet in width. Place a layer of live willow and dogwood cuttings onto the planting soil layer as shown on the cross section drawings. The cuttings will up to 10 feet in length in order to extend the width of the prepared soil lifts. Place additional potted native riparian shrub and tree species into the exposed edge of the soil lift as specified in the planting schedule. Butt ends of the cuttings can be up to four inches in diameter; exposed ends of the cuttings will extend no more than one foot riverward from the finished slope. Cover the layer of cuttings with an additional 6 to 8 inches of planting soil and compact lightly with a single pass of the trackhoe. Once installed in this manner, each layer of cuttings will be embedded in a one foot minimum thickness of Groco-amended planting soil.

3. Import selected levee fill soils to the site and compact them in eight inch lifts to form fill layers between the layers of live cuttings. Each fill layer will be composed of three compacted soil lifts, extending the full length of the riverbank within the project area. Each finished fill layer will be wrapped with coir fabric for erosion protection.

4. Selected fill soils will be supplemented in lifts with crushed rock materials as noted above during periods of rainfall to provide for adequate compaction and to prevent pumping of mud in areas subject to equipment passage and truck traffic.

5. Alternate willow layers and coir wrapped fill and reconstruct lower and upper embankment slopes to finished grade as shown on the cross section drawings and plan sheet.

6. The embankment slope lifts will be brought as close as possible to finished grade and mulched with straw on a daily basis as needed during any anticipated periods of rainy weather.

7. Hydroseed any remaining disturbed soil surfaces following completion of all construction activities.

8. Stake slope areas subject to winter inundation with coir fabric over the completed hydroseed cover as needed to prevent winter erosion.

9. Plant middle and upper slope areas with potted upland native shrubs during the following plant dormancy season (October 1 through February 28) in accordance with planting plan and plant schedule shown on the project drawings.

10. Water plants and grass seed as needed, twice a week minimum, until the onset of fall rains.

Equipment Used: PC 225, 230 and 330 track hoes, 10 CY dump trucks, 18 CY belly dump trucks, pickup trucks, 1 ton flatbed trucks, 30' bed trash hauler, hydroseed truck, water truck, and D6 bulldozer.

Long Term ESC Monitoring:

All stabilized slope areas will be monitored for signs of erosion during wet winter months and immediately repaired. Repairs can include straw mulching, straw mulch packing of incipient rills, gravel patching of incised rills, additional placement of topsoil, additional hand- and/or hydroseeding, placement of washed rock filter berms, and localized placement of additional silt fencing. The goal is to maintain a vigorous establishment of dense, deeply rooted erosion control grasses and native riparian vegetation on all disturbed slope areas at all times.

Long Term Project Monitoring

For details on long term monitoring of structural integrity, riparian habitat, instream habitat and fish habitat utilization monitoring, please refer to the monitoring plan in Chapter 11.

5.6 Construction Schedule

Inwater portions of this project are proposed to occur over a four week period between June 15 and August 15 (or as otherwise authorized by permit conditions), sometime between 2001 and 2003, which coincides with the anticipated window for instream construction to be established by the WDFW Area Habitat Biologist. However this window is subject to change due to the chinook and bull trout listings. Out-of-water work may continue until October 15. Potted plant installation will take place during the ensuing plant dormancy season (October 1 through February 28).

6 PROJECT DESCRIPTION AND SITE SPECIFIC INFORMATION, FRAGER ROAD REVETMENT REPAIR

6.1 Project Location

The vicinity of the Frager Road Revetment Repair is shown in Figure 6.1, and the project area and project site are shown in Figure 6.2. This project site is at RM 18.5 on the left bank of the Green River within the City of Kent. The site lies in the Southwest Quarter of Section 10 of Township 22, Range 4 East Meridian, approximately one-half mile upstream from the S. 212th St. bridge.

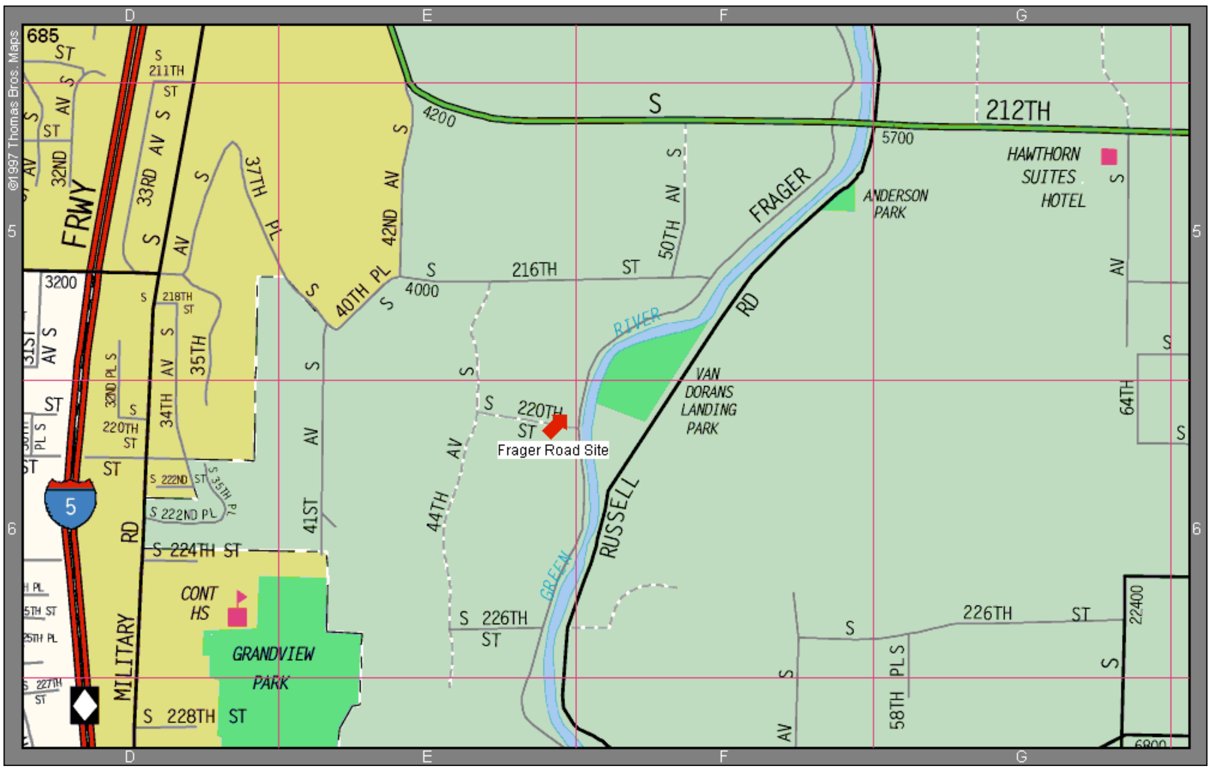

Figure 6.1 Frager Road Revetment Repair Vicinity Map

6.2 Site-Specific Conditions

A slope failure extends from near the top of bank adjoining the road shoulder to below the OHWM along 175 lineal feet of the river bank. Low flow just upstream from the failure enters a deep pool just downstream from an exposed, buff colored clay shelf that forms a slight low-flow channel constriction three feet below the OHWM. The channel then enters a well defined curve to the right, producing a well-defined, deep, relatively stagnant side eddy along the left bank at the failure location. This moves the thalweg into the left bank as it exits the failure location.

The buff-colored silty clay unit is commonly present throughout this portion of the lower Green River valley, and creates well-defined, locally undercut shelf exposures where present. Based on inspection of previous repairs in failed slope materials overlying this buff clay shelf, there is commonly present a soft, saturated blue clay with inclusions of very soft peat. This unit appears to be associated with prehistoric slough and overbank channel wetland infill deposits within the historic floodplain and may exhibit year around seepage and spring activity. Drainage through this unit is impeded both by the blue clay and especially by the underlying buff clay units. Overlying sands associated with historic White River discharge and more recent silty deposits from Green River flood discharge become highly saturated during prolonged flood storage releases from the Eagle Gorge Reservoir at HHD. Together with elevated valley floor winter groundwater levels affecting these units at shallow depths overlying the above-mentioned clay deposits, this saturation of river embankment soils has resulted in number slumping failures at this site following drawdown of river stage after evacuation of floodwater from the reservoir .

Habitat and Fish Utilization Surveys

Riparian Habitat: On October 5, 1999 King County and USFWS staff collected habitat data and surveyed fish utilization within the 40 meter long project reach, and a 65 meter control reach[1] just upstream from the Meeker Street foot bridge on the left bank upstream from the proposed Narita Levee repair project (see data forms in Appendix E). The river discharge that day was not recorded. The average flow in the project reach was 2.5 feet/second in a stretch of run habitat, and 4.0 feet/second in a stretch of rapid habitat. The average flow in the control reach was 0.5 feet/second in a segment of lateral pool habitat and 0.3 in a segment of backwater habitat. Little native riparian vegetation was present along the banks of both the project and control reaches due to historic vegetation management practices, including maintenance of the facilities in an oversteepened condition. Riparian cover was absent along the project reach, but was present along 10 percent of the control reach. Most of the lower bank riparian vegetation in both the project and control reaches consisted of blackberries and reed canarygrass. Sixty-five percent of the bankline along the project reach had overhanging vegetation in the form of reed canarygrass growing out of a large soil slump extending from the toe of the facility several feet into the channel, but no overhanging vegetation was present along the control reach. The upper bank of both the project and control reaches consisted mainly of blackberries. The edge of Frager Road lies immediately adjacent to the top of the bank along both the project and control reaches.

Instream Habitat: Within both the project and control reaches, a single primary habitat was identified, characterized as a narrow, relatively shallow lateral scour pool. Within the project reach, two secondary habitats were identified: a 15 meter segment of riffle habitat near the upstream end of the project, and a 15 meter segment of run habitat near the downstream end of the project, each of which contained a tertiary habitat, namely a backwater eddy that differed in terms of average water velocity with the riffle habitat having somewhat faster water. The control reach contained two distinguishable secondary habitats: a 54 meter long lateral scour pool, and an 11 meter long lateral scour pool terminating in a tertiary habitat, namely a backwater eddy. Instream cover in the project reach consisted of vegetation along one meter of the bankline, and branching woody debris along 15 meters of the bankline. Instream cover in the control reach consisted entirely of riprap. The substrate in the project reach consisted of embedded silt. The substrate in the control reach consisted of unembedded coarse sand. The overall habitat complexity in the project reach was judged to be moderate because of the cover afforded by the vegetation and branching woody debris. The overall

[1] This same 65 meter control reach was also designated as the control reach for the Boeing and Pipeline levee repair projects.

habitat complexity in the control reach was judged to be moderate because the presence of a backwater eddy and indented riprap.

Fish Survey: No fish were seen in either the project or control reaches.

Future Surveys: Additional habitat and fish surveys are planned starting in February 2001.

6.3 Proposed Action

Failed slope materials will be excavated to create a construction bench above the OHWM. Operating from this bench, a track mounted excavator will install a series of trenches extending from the water's edge to the landward edge of the construction bench. An alternating sequence of 60-inch diameter reinforced concrete culverts and LWD pieces will be imbedded into these trenches, perpendicular to the bankline. A rock toe buttress will be keyed in to secure both the culverts and LWD pieces into the revetment toe. The culverts will be installed below the OHWM as deeply as possible, with the riverward ends exposed to create habitat niches. Rootwads of the LWD will be positioned to overhang and shelter each culvert opening. Additional LWD pieces will be installed along the bankline, parallel to the bank, overlapping each other in a downstream orientation to further shelter the niches. Slopes above the construction bench and OHWM will be reconstructed with native willow and dogwood cuttings, and other native riparian trees and shrubs, layered in topsoil between lifts of clean sand and gravel fill, wrapped with coir fabric for erosion protection. Upper bank slopes will be similarly reconstructed, with alternating lifts of native vegetation layers and coir-wrapped fill soils to flatten and revegetate the overall slope profile to the maximum extent possible, given the constraint posed by the existing Frager Road shoulder location.[1]

6.4 Purpose and Need

This facility protects Frager Road S. which provides freeboard for flood containment protecting western portions of the Green River Valley between Frager Road S. and the valley wall to the west. The project purpose is to restore structural stability of the flood control facility and to improve salmonid and riparian habitat at this location.

6.5 Construction Activities

Temporary Erosion and Sediment Control (TESC)

1. The following will be brought to the site and staged on a daily basis as needed:
   - Straw bales for slope mulching
   - Silt fencing for perimeter siltation control
   - Crushed or washed rock for control of soil pumping on exposed soils in heavy traffic areas
   - 5/8 inch minus crushed rock for staging areas and road shoulders
   - Pea gravel for filter berms and silt fence installations
   - Hand brooms, street sweepers, and wash trucks for control of sediments on paved traffic surfaces.

2. An undisturbed band of existing vegetation will be left intact along the waterline until excavation of failed or damaged toe buttress areas for installation of crushed rock bedding,

[1] If additional right-of-way can be acquired, an even flatter slope configuration will be proposed for this project.

toe rock, LWD anchor rocks, habitat niche culverts, and LWD.

3. A turbidity curtain (see Figure 10.1 and Table 10.5) will be installed at the site prior to in-water construction.

4. All in-water construction will occur between June 15 and August 15 (or as otherwise authorized by permit conditions), sometime between 2001 and 2003 (or as otherwise authored by permit conditions), to avoid extended periods of rainy weather and high river discharge, and to coincide with the period of minimum habitat utilization by juvenile and adult salmonids.

5. All paved traffic areas will be kept free from sediment accumulations by daily sweeping and washing.

6. Turbidity will be monitored at the construction site, at flagged sampling stations 50 feet upstream from the excavation area and 250 feet downstream from the excavation area to facilitate compliance with limits on turbidity set forth in Washington Department of Ecology Order No. DE 97WQ-007 (February 24, 1997), and at a flagged sampling station located one-quarter mile downstream from the site.

<u>Construction Sequence; Toe and Bank Repair</u>

1. Stake limits of construction area at site.

2. Trench silt fence into riverbank slope, at lower limits of construction bench area, leaving an intact band of undisturbed vegetation downslope from the silt fence location, extending to the OHWM.

3. Place pea gravel berm to anchor silt fence into trench.

4. Excavate upper embankment slopes to create and shape ramps to access construction bench excavation area, from both upstream and downstream of bench area.

5. Operating from the upper bank and from the ramps as needed, excavate the construction bench, landward of the silt fence.

6. Starting at the downstream end of the project, install the floating turbidity curtain to isolate the instream work area from the flowing stream.

7. Starting at downstream end of the project, construct toe repairs in fifteen foot long (maximum) increments, as follows:

8. Starting at the downstream end of the project, clear and grub existing blackberries and reed canarygrass from the lower bank slope, above the OHWM, in 15 foot increments. Export these plant and soil materials to an approved disposal location (Pacific Topsoil site in Kent or King County Roads Division soil recycling center in Renton).

9. Excavate existing failed levee rip-rap and unsuitable subgrade materials from the lower embankment slopes, above the water surface elevation, in the same 15 foot increment. Export

these materials to an approved disposal location (Pacific Topsoil site in Kent or King County Roads Division soil recycling center in Renton).

10. Excavate failed or damaged toe buttress areas and unsuitable subgrade materials from below the water surface elevation for placement of new crushed rock bedding, toe rock, habitat niche culverts, and LWD anchor rocks, in the same 15 foot increments. Working from the embankment side toward the water's edge, leave an intact earthen "plug" at the riverward edge of the toe rock and LWD trench excavation area until the moment of actual LWD, toe buttress bedding, habitat niche culvert, and toe rock placement in order to minimize turbidity.

11. Excavate and remove the earthen "plug" from along the water's edge, completing the excavation to depth as rapidly as possible. Immediately place 2-1/4" crushed railroad ballast and quarry spalls to stabilize the exposed riverbed and embankment soils, and to provide suitable bedding conditions for placement of LWD, habitat niche culverts, and toe rock. Complete this work within the same 15 foot increments.

12. Place habitat niche culverts and LWD within the prepared toe trench bedding area at a 12 foot spacing, as shown on the plan drawings. Place additional toe buttress rocks to firmly secure the LWD and culverts in place, and to secure the entire toe buttress against undercutting erosion, working within the same 15 foot increments as above. Level the top edge of the rock toe buttress at a finished elevation approximately one foot above the OHWM, using light loose rip-rap, 2-1/2" crushed ballast, and 1-1/4" crushed gravel to provide a secure base for subsequent soil lifts and plantings.

13. Using the trackhoe bucket, gently place the additional coniferous LWD pieces into the water column, securing them along the bankline to the imbedded LWD with the chain attachments, and to each other, starting at the downstream end and proceeding upstream. Overlap cut log ends riverward of the next rootwad protruding downstream and secure overlapped logs to each other with additional one-inch diameter anchor chain. The LWD should overlap in a downstream direction as shown on the plan sheets. To the maximum extent, anchoring of the LWD should seek to secure the logs below the OHWM as fully as possible, while minimizing the potential for individual logs to float up, onto the bankline, during flood events. Precise placement of individual LWD pieces will be accomplished under the supervision of the project engineer and the Senior Ecologist.

14. Proceed as specified above in 15 foot increments from downstream to upstream, to the end of the project repair reach.

15. Remove turbidity curtain.

<u>Levee Slope Reconstruction</u>

11. Following completion of all instream toe buttress construction and LWD placement, place a 3-inch lift of crushed quarry screenings the full length of the toe buttress along the top edge of the newly placed rock, logs, and culverts. Seal all underlying voids and to create a secure base for subsequent placement of soil lifts and planting layers. Make sure the top surface of the screenings is located at a minimum of one foot above the OHWM elevation, in order to provide adequate cover over the top of the culverts.

12. Place an 8-inch layer of Groco-amended planting soil (≥20% Groco) along the full length of the bench adjoining the riverbank within the project area, extending for a minimum of eight feet in width. Place a layer of live willow and dogwood cuttings onto the planting soil layer as shown on the cross section drawings. The cuttings will up to 10 feet in length in order to extend the width of the prepared soil lifts. Place additional native riparian shrub and tree species into the exposed edge of the soil lift as specified in the planting schedule. Butt ends of the cuttings can be up to four inches in diameter; exposed ends of the cuttings will extend no more than one foot riverward from the finished slope. Cover the layer of cuttings with an additional 6 to 8 inches of planting soil and compact lightly with a single pass of the trackhoe. Once installed in this manner, each layer of cuttings will be embedded in a one foot minimum thickness of Groco-amended planting soil.

13. Import selected levee fill soils to the site and compact them in eight inch lifts to form fill layers between the layers of live cuttings. Each fill layer will be composed of three compacted soil lifts, extending the full length of the riverbank within the project area. Each finished fill layer will be wrapped with coir fabric for erosion protection.

14. Selected fill soils will be supplemented in lifts with crushed rock materials as noted above during periods of rainfall to provide for adequate compaction and to prevent pumping of mud in areas subject to equipment passage and truck traffic.

15. Alternate willow layers and coir wrapped fill and reconstruct the embankment slopes to finished grade as shown on the cross section drawings and plan sheet.

16. The embankment slope lifts will be brought as close as possible to finished grade and mulched with straw on a daily basis as needed during any anticipated periods of rainy weather.

17. Hydroseed any remaining disturbed soil surfaces following completion of all construction activities.

18. Stake slope areas subject to winter inundation with coir fabric over the completed hydroseed cover as needed to prevent winter erosion.

19. Plant middle and upper slope areas with potted upland native shrubs and trees during the following plant dormancy season (October 1 through February 28) in accordance with planting plan and plant schedule shown on the project drawings.

20. Water plants and grass seed as needed, twice a week minimum, until the onset of fall rains.

Equipment Used: PC 225, 230 and 330 track hoes, 10 CY dump trucks, 18 CY belly dump trucks, pickup trucks, 1 ton flatbed trucks, 30' bed trash hauler, hydroseed truck, water truck, and D6 bulldozer.

Long Term ESC Monitoring

All stabilized slope areas will be monitored for signs of erosion during wet winter months and immediately repaired. Repairs can include straw mulching, straw mulch packing of incipient rills, gravel patching of incised rills, additional placement of topsoil, additional hand- and/or hydroseeding, placement of washed rock filter berms, and localized placement of additional silt fencing. The goal is to maintain a vigorous establishment of dense, deeply rooted erosion control grasses and native riparian vegetation on all disturbed slope areas at all times.

Long Term Project Monitoring

For details on long term monitoring of structural integrity, riparian habitat, instream habitat and fish habitat utilization monitoring, please refer to the monitoring plan in Chapter 11.

6.6 Construction Schedule

Inwater portions of this project are proposed to occur over a four week period between June 15 and August 15 (or as otherwise authorized by permit conditions), sometime between 2001 and 2003, which coincides with the anticipated window for instream construction to be established by the WDFW Area Habitat Biologist. However this window is subject to change due to the chinook and bull trout listings. Out-of-water work may continue until October 15. Potted plant installation will take place during the ensuing plant dormancy season (October 1 through February 28).

7 PROJECT DESCRIPTION AND SITE SPECIFIC INFORMATION, NARITA LEVEE REPAIR.

7.1 *Project Location*

The vicinity of the Narita Levee Repair is shown in Figure 7.1, and the project area and project site are shown in Figure 7.2. This project site is between RM 21.0 and 21.2 on the right bank of the Green River within the City of Kent west of the Riverbend Golf Complex. The site lies in the Southeast Quarter of Section 23, Township 22 North, Range 4 East, West Meridian, approximately 0.2 RM north of the Meeker Street bridge.

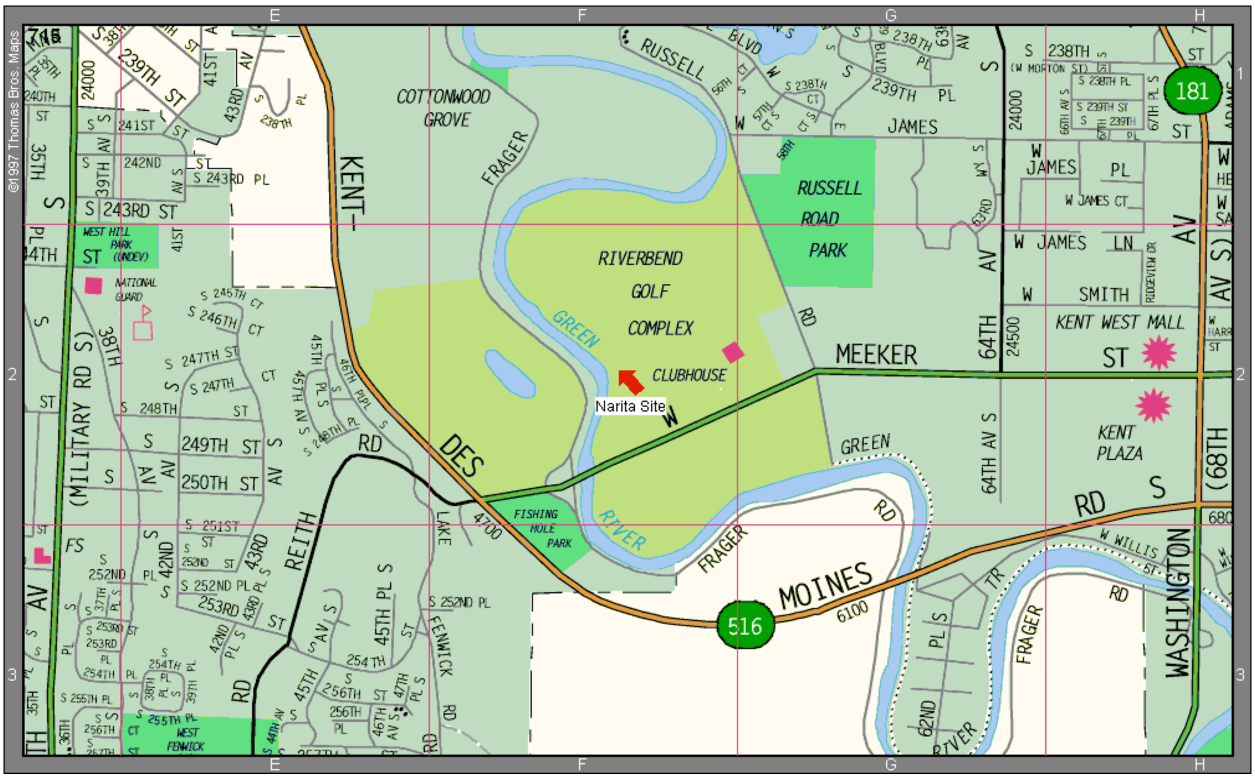

Figure 7.1 Narita Levee Repair Vicinity Map

7.2 *Site-Specific Conditions*

The Narita Levee is named after a family farm formerly situated landward of the facility, now a municipal golf course operated by the City of Kent. The levee was originally built in 1963 by King County, and comprises two segments totaling 3,300 lineal feet along meander bends between RM 21.0 and 22.9 along the right bank of the Green River. This repair project has been divided into two phases. Phase 1, conducted in April of 1999, consisted of excavation of a low bench approximately 12 feet above OHWM, and relocation of a portion of the 16-foot wide levee crest, which is occupied by an asphalt-paved bicycle trail, approximately 25 feet landward of its former configuration along a

550 foot segment of the levee. Phase 2, proposed for construction between June 15 and August 15 (or as otherwise authorized by permit conditions), sometime between 2001 and 2003, will consist of toe reconstruction and habitat restoration within this same 550 foot project segment

The total channel width (facility top width) ranges from 120 to 180 feet, and the OHWM width ranges from 65 to 80 feet. The planform of the river within this reach is meandering; the facility repair site is an outside bend. The project reach and adjacent reaches upstream and downstream show the effects of extreme channelization, bank hardening and floodplain filling to create a golf course, bridges, roadways, commercial buildings, parking lots, a bicycle trail and other public and private infrastructure. Hydraulic controls at this site include channel confinement per se (including the Frager Road Revetment on the opposite bank), operation of the Howard Hanson Dam upstream by the USACE and the historic diversion of the White River away from the Green River upstream from the site.

The streambed of this regime channel at this site is composed of organic materials, silt and sand; no gravels, boulders or bedrock are present. A deep pool tails out just upstream from the project. This pool is formed downstream of a low flow chute under the footbridge downstream from the Meeker Street Bridge, along the right bank. Here the channel has been historically encroached by relict bridge piers, which are still visible. The channel constriction in this area is covered with cobbles and quarry spalls. The facility is subject to episodic erosion, as evidenced by toe scour and bank slumping along portions of the facility. These problems are exacerbated by the excessive steepness of the facility, which was repaired during Phase 1 of this project (see Sections 7.3 and 7.5).

Prior to completion of Phase 1, over 90 percent of the riparian vegetation covering the riverward revetment slope consisted of Himalayan blackberry (*Rubus discolor*) and reed canarygrass (*Phalaris arundinacea*). Modest amounts of willows (*Salix* spp.) were (and still are) present along the bankline just upstream, where they were installed by the City of Kent in 1991. There is a single mature alder near the middle of the project reach, but elsewhere at this project site the relative paucity of complex overhanging vegetation and tree canopy revetment results in exposure of instream biota (including salmonids) to both predators and warm water temperatures, and deprives terrestrial wildlife of riparian habitat niches. A 16 foot wide asphalt bicycle/pedestrian trail occupies the newly set back 20 foot wide levee top. The backslope vegetation consists of manicured golf greens and clusters of immature, mostly non-native landscaping trees, most of which are conifers.

Because of the extensive channel straightening and simplification throughout this project site, the channel generally lacks channel-diversifying obstructions or hard elements such as rocks or logs except for limited volumes of partially decayed LWD that survived snagging operations conducted early in this century. As a result, the instream habitat at this site can be characterized as a long, continuous, riprap-lined lateral scour pool. As such, little hydraulic refuge or escape cover is available to upstream-migrating adult salmonids during the late summer, fall and winter months, or to juvenile salmonids during high, winter flows, compared to conditions in channels with hard elements in the channel, such as LWD and/or boulders. The nearly complete lack of LWD within the project reach is due to historic removal and vegetation management practices (including maintenance of the levee in an oversteepened condition) that suppressed the natural succession of riparian vegetation. This condition also reflects USCACE levee maintenance requirements, which call for removal of all woody vegetation in excess of four inches dbh, thus limiting future LWD recruitment at this site. The GRFCZD no longer implements this federal policy.

Habitat and Fish Utilization Surveys
Riparian Habitat: On October 5, 1999 King County and USFWS staff collected habitat data and surveyed fish utilization within a 55 meter long project reach, and a 65 meter control reach[1] just upstream from the Meeker Street foot bridge on the left bank upstream from the proposed Narita Levee repair project (see data forms in Appendix E). The river discharge that day was not recorded. The average flow in the project reach was 0.75 feet/second. The average flow in the control reach was 0.5 feet/second in a segment of lateral pool habitat and 0.3 in a segment of backwater habitat. Little native riparian vegetation was present along the banks of both the project and control reaches project due to historic vegetation management practices, including maintenance of the facilities in an oversteepened condition. Ten percent of the project reach had riparian cover, and 40 percent of the control reach had overhanging vegetation. Riparian cover was present along 10 percent of the project reach, but no overhanging vegetation was present along the control reach. Most of the lower bank riparian vegetation in both the project and control reaches consisted of blackberries and reed canarygrass. The upper bank of the project reach was sloped back and benched in 1999 during Phase 1 of this project, and a portion of the upper slope that will not be disturbed by further earthmoving during completion of the project were planted with native shrubs and trees during the 1999-2000 plant dormancy season. Downslope from the bench, the lower bank within the project reach consists mainly of blackberries and reed canarygrass, although a clump of alders are also present. The back slope of the project reach is occupied by a golf course landscaped with grass and immature trees (a mixture of Douglas fir and cultivars). The edge of Frager Road lies immediately adjacent to the top of the bank along the control reach.

Instream Habitat: Within the project reach, a 55 meter long primary habitat was identified, characterized as a narrow, relatively shallow lateral scour pool. The project reach also contained a 55 meter long secondary habitat characterized as slow-moving, relatively shallow water. The control reach contained two secondary habitats: a 54 meter long lateral scour pool, and an 11 meter long lateral scour pool terminating in a tertiary habitat, namely a backwater eddy. Instream cover in the project reach consisted of riprap along the 55 meter segment of bankline, and vegetation along 10 meters of bankline, in addition to the riprap. Instream cover in the control reach consisted entirely of riprap. The substrate in the project reach consisted of loosely embedded coarse sand. The substrate in the control reach consisted of embedded fine silt. The overall habitat complexity in the project reach was judged to be moderate because of the cover afforded by the vegetation and indented riprap. The overall habitat complexity in the control reach was judged to be moderate because the presence of a backwater eddy and indented riprap.

Fish Survey: No fish were seen in either the project or control reaches.

Future Surveys: Additional habitat and fish surveys are planned starting in February 2001.

7.3 Proposed Action

The primary goals of the Narita Levee Repair project are to (1) restore structural stability to a 550-foot segment of the Narita Levee damaged by toe scour and bank slumping during the 1995-1996 floods, and (2) improve instream and riparian habitat for salmonids and terrestrial wildlife.

Phase 1 of this project was completed in April, 1999. Phase 2, currently proposed for construction between June 15 and August 15 (or as otherwise authorized by permit conditions), sometime between

[1] This same 65 meter control reach was also designated as the control reach for the Boeing and Pipeline levee repair projects.

200 and 2003, will include (1) installation of toe rock scoured out during the 1995-1996 floods; instream installation of 59 pieces of coniferous LWD (all but two of which will have intact rootwads) installed within the toe and anchored with large toe rock; (3), installation of live willow and red-osier dogwood brush layers within all disturbed portions of the lower bank, and (4) revegetation of all portions of the site that were not previously revegetated during Phase 1 of this project (see below).

7.4 Purpose and Need

This facility protects the adjacent the City of Kent's Riverbend Golf Course, and provides freeboard and flood containment protecting eastern portions of the Green River Valley, including commercial properties in the vicinity of James and Meeker Streets, residential properties in the vicinity of 64th Ave. So., and remaining developed portion of the east Green River valley downstream to I-405. The project purpose is to restore structural stability of the flood control facility and to improve salmonid and riparian habitat at this location.

7.5 Construction Activities

All construction activities have been and will continue to be performed subject to applicable federal, state, and county permit requirements and conditions, with the exception that current USACE standards calling for wholesale, routine devegetation of PL 84-99 non-federal levees will not be adhered to.

Narita Levee Repair Phase 1 (completed in 1999):

1. The following were brought to the site and staged on a daily basis as needed:
   - Straw bales for slope mulching
   - Silt fencing for perimeter siltation control
   - Crushed or washed rock for control of soil pumping on exposed soils in heavy traffic areas
   - 2-1/2 inch minus crushed rock for construction ramps
   - 1-1/4 inch minus crushed rock for soil lifts
   - 5/8 inch minus crushed rock for staging areas and road shoulders
   - washed pea gravel for filter berms and silt fence installations
   - Hand brooms, street sweepers, and wash trucks for control of sediments on paved traffic surfaces

2. A silt fence was installed along the full 550 feet of the project site 12 feet above the OHWM. The fence was keyed into place with a one foot high by two feet wide filter berm.

3. Temporary access ramps were excavated from the top of bank at the upstream and downstream ends of the project segment into the backslope area of the levee between the existing asphalt trail surface and the landward edge of the new setback alignment. The golf course fairways and landscaping were modified to accommodate the setback.

4. Trail traffic was re-routed and the asphalt trail was removed and disposed of at Washington Demolition Co. for recycling.

5. The existing levee fill was excavated and replaced in compacted lifts to form the new setback levee alignment. Additional imports of clean, well graded soil were also placed into these lifts as required to reconstruct the levee up to the freeboard crest elevation. Imported fill soils included ledge rock screenings from the Enumclaw quarry and recycled soils from the King County Roads

Division stockpile in Renton. Native silts and sands were used with minor amounts of Groco-amended topsoil (also from recycled stockpiles in Renton) to surface the completed levee setback. slope

6. The oversteepened, slumping riverward embankment slopes were excavated at slope angles ranging from 2H:1V to 3H:1V, creating a midslope bench measuring up to 25 feet in width and positioned approximately 12 feet above the OHWM.

7. All disturbed soil surfaces were straw mulched daily during the work.

8. All disturbed soil surfaces were immediately hydroseeded following the above work.

9. The newly excavated upper bank slope was planted with potted red-osier dogwood (*Cornus stolonifera*), Pacific ninebark (*Physocarpus capitatus*), salmonberry (*Rubus spectabilis*), thimbleberry, (*Rubus parviflorum*) and snowberry (*Symphoricarpos alba*), lodgepole pine (pinus contorta), Douglas hawthorn (*Cratageus douglasii*), bitter cherry (*Prunus emarginata*), western crabapple (*Malus fusca*), cascara, (*Rhamnus purshiana)* Scouler's and Sitka willows (*Salix scouleriana* and *S. sitchensis*), [add rest of shrubs] during the 1999-2000 dormant season.

Equipment Used: PC 220 track hoe, D3 bulldozer, vibratory roller/compactor, 10 CY dump trucks, pickup trucks, 1 ton flatbed trucks, 30' bed, water truck, hydroseed truck.

Proposed Narita Levee Repair Phase 2

Temporary Erosion and Sediment Control (TESC)

1. The following will be brought to the site and staged on a daily basis as needed:
   - Straw bales for slope mulching
   - Silt fencing for perimeter siltation control
   - Crushed or washed rock for control of soil pumping on exposed soils in heavy traffic areas
   - 5/8 inch minus crushed rock for staging areas and road shoulders
   - Pea gravel for filter berms and silt fence installations
   - Hand brooms, street sweepers, and wash trucks for control of sediments on paved surfaces.

2. An undisturbed band of existing vegetation will be left intact along the waterline until excavation of failed or damaged toe buttress areas for installation of crushed rock bedding, toe rock, LWD anchor rocks, and LWD.

3. A turbidity curtain (see Figure 10.1 and Table 10.5) will be installed at the site prior to in-water construction.

4. All paved traffic areas will be kept free from sediment accumulations by daily sweeping and washing.

5. Turbidity will be monitored at the construction site at flagged sampling stations 50 feet upstream from the excavation area and 250 feet downstream from the excavation area to facilitate compliance with limits on turbidity set forth in Washington Department of

Ecology Order No. DE 97WQ-007 (February 24, 1997), and at a flagged sampling station located one quarter mile downstream from the site.

Construction Sequence; Toe and Bank Repair

1. Stake limits of construction area at site.

2. Close the trail to recreational traffic during project construction.

3. Shape ramps to access bench from existing levee crest upstream and downstream of bench area.

4. Starting at the downstream end of the project, install the floating turbidity curtain in 175-foot-long increments to isolate the instream work area(s) from the flowing stream.

5. Starting at downstream end of the project, construct toe repairs in fifteen foot long (maximum) increments, as follows:

6. Starting at the downstream end of the project, clear and grub existing blackberries and reed canarygrass from the lower bank slope, above the OHWM, in 15 foot increments. Retain the single immature alder shown on the plans. Export these plant and soil materials to an approved disposal location (Pacific Topsoil site in Kent or King County Roads Division soil recycling center in Renton).

7. Excavate existing failed levee rip-rap and unsuitable subgrade materials from the lower embankment slopes, above the water surface elevation, in the same 15 foot increments. Export these materials to an approved disposal location (Pacific Topsoil site in Kent or King County Roads Division soil recycling center in Renton).

8. Excavate failed or damaged toe buttress areas and unsuitable subgrade materials from below the water surface elevation for placement of new crushed rock bedding, toe rock, and LWD, in the same 15 foot increments. Working from the embankment side toward the water's edge, leave an intact earthen "plug" at the riverward edge of the toe rock and LWD trench excavation area until the moment of actual toe buttress bedding, LWD, and rock placement in order to minimize turbidity.

9. Excavate and remove the earthen "plug" from along the water's edge, completing the excavation to depth as rapidly as possible. Immediately place 2-1/4" crushed railroad ballast and quarry spalls to stabilize the exposed riverbed and embankment soils, and to provide suitable bedding conditions for placement of toe rock and LWD. Complete this work within the same 15 foot increments.

10. Place LWD within the prepared toe trenches as shown on the plan sheets. Place toe rocks in place to firmly secure the LWD in place, and to secure the entire toe buttress against undercutting erosion, working within the same 15 foot increments as above. Level the top edge of the rock toe buttress at a finished elevation approximately one foot above the OHWM, using light loose rip-rap, 2-1/2" crushed ballast, and 1-1/4" crushed gravel to provide a secure base for subsequent soil lifts and plantings.

11. Using the trackhoe bucket, gently place additional coniferous LWD pieces into the water column, securing them along the bankline to the anchor logs with the chain attachments, and to each other, starting at the downstream end and proceeding upstream. Overlap cut log ends riverward of the next rootwad protruding downstream and secure overlapped logs to each other with additional one-inch diameter anchor chain. The LWD should overlap in a downstream direction as shown on the plan sheets. To the maximum extent, anchoring of the LWD should seek to secure the logs below the OHWM as fully as possible, while minimizing the potential for individual logs to float up, onto the bankline, during flood events. Precise placement of individual LWD pieces will be accomplished under the supervision of the project engineer and the Senior Ecologist.

12. Proceed as specified above in 15 foot increments upstream, relocating the floating turbidity curtain as needed for subsequent portions of the instream work, to the end of the project repair reach.

13. Remove turbidity curtain.

Levee Slope Reconstruction

1. Following completion of all instream toe buttress construction and LWD placement, place a 3-inch lift of crushed quarry screenings the full length of the toe buttress along the top edge of the newly placed rock. Seal all underlying voids and to create a secure base for subsequent placement of soil lifts and planting layers. Make sure the top surface of the screenings is located at a minimum of six inches above the OHWM elevation.

2. Place an 8-inch layer of Groco-amended planting soil (≥20% Groco) along the full length of the bench adjoining the riverbank within the project area, extending for a minimum of eight feet in width. Place a layer of live willow and dogwood cuttings onto the planting soil layer as shown on the cross section drawings. The cuttings will up to 10 feet in length in order to extend the width of the prepared soil lifts. Place additional native riparian shrub and tree species into the exposed edge of the soil lift as specified in the planting schedule. Butt ends of the cuttings can be up to four inches in diameter; exposed ends of the cuttings will extend no more than one foot riverward from the finished slope. Cover the layer of cuttings with an additional 6 to 8 inches of planting soil and compact lightly with a single pass of the trackhoe. Once installed in this manner, each layer of cuttings will be embedded in a one foot minimum thickness of Groco-amended planting soil.

3. Import selected levee fill soils to the site and compact them in eight inch lifts to form fill layers between the layers of live cuttings. Each fill layer will be composed of three compacted soil lifts, extending the full length of the riverbank within the project area. Each finished fill layer will be wrapped with coir fabric for erosion protection.

4. Selected fill soils will be supplemented in lifts with crushed rock materials as noted above during periods of rainfall to provide for adequate compaction and to prevent pumping of mud in areas subject to equipment passage and truck traffic.

5. Alternate willow layers and coir wrapped fill and reconstruct lower embankment slopes to finished grade as shown on the cross section drawings and plan sheet.

6. The lower embankment slope lifts will be brought as close as possible to finished grade and mulched with straw on a daily basis as needed during any anticipated periods of rainy weather.

7. Hydroseed any remaining disturbed soil surfaces following completion of all construction activities.

8. Stake slope areas subject to winter inundation with coir fabric over the completed hydroseed cover as needed to prevent winter erosion.

9. Plant middle and upper slope areas with potted upland native shrubs during the following plant dormancy season (October 1 through February 28) in accordance with planting plan and plant schedule shown on the project drawings.

10. Water plants and grass seed as needed, twice a week minimum, until the onset of fall rains.

Equipment Used: PC 225, 230 and 330 track hoes, 10 CY dump trucks, 18 CY belly dump trucks, pickup trucks, 1 ton flatbed trucks, 30' bed trash hauler, hydroseed truck, water truck, and D6 bulldozer.

Long Term ESC Monitoring

All stabilized slope areas will be monitored for signs of erosion during wet winter months and immediately repaired. Repairs can include straw mulching, straw mulch packing of incipient rills, gravel patching of incised rills, additional placement of topsoil, additional hand- and/or hydroseeding, placement of washed rock filter berms, and localized placement of additional silt fencing. The goal is to maintain a vigorous establishment of dense, deeply rooted erosion control grasses and native riparian vegetation on all disturbed slope areas at all times.

Long Term Project Monitoring

For details on long term monitoring of structural integrity, riparian habitat, instream habitat and fish habitat utilization monitoring, please refer to the monitoring plan in Chapter 11.

7.6 Construction Schedule

Inwater portions of this project are proposed to occur over a four week period between June 15 and August 15 (or as otherwise authorized by permit conditions), sometime between 2001 and 2003, which coincides with the anticipated window for instream construction to be established by the WDFW Area Habitat Biologist. However this window is subject to change due to the chinook and bull trout listings. Out-of-water work may continue until October 15, 2000. Potted plant installation will take place during the ensuing plant dormancy season (October 1 through February 28).

8 PROJECT DESCRIPTION AND SITE SPECIFIC INFORMATION, PIPELINE LEVEE REPAIR.

8.1 Project Location

The vicinity of the Pipeline Levee Repair is shown in Figure 8.1, and the project area and project site are shown in Figure 8.2. The Pipeline Levee Repair site is located on the right bank of the Green River at RM 21.9 in the Southeast Quarter of Section 23, Township 22 North, Range 4 East, West Meridian within the City of Kent, due east of the south terminus of Russell Road S. The south terminus of S. Russell Road provides access to the downstream end of the site; the upstream end of the facility is accessible through the terminus of S. Willis St. within the Signature Pointe apartment complex.

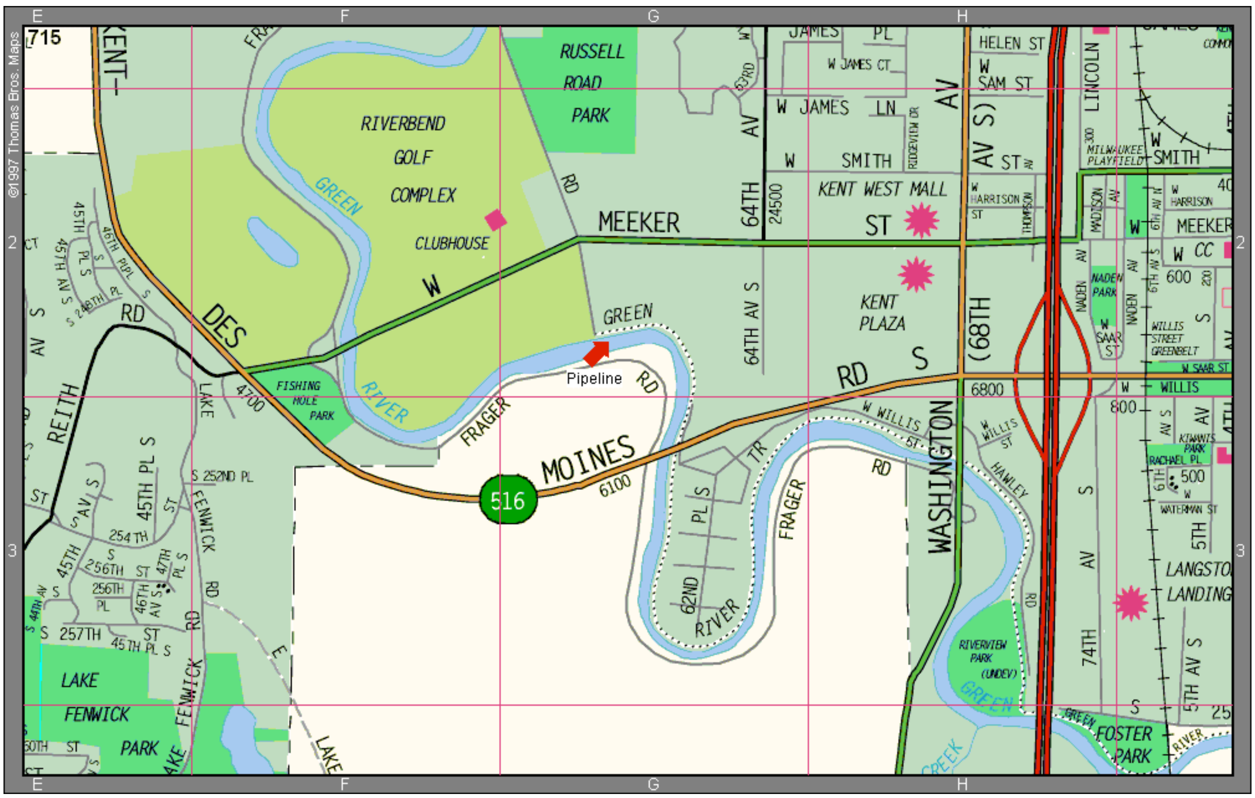

Figure 8.1 Pipeline Levee Repair Vicinity Map

8.2 Site-Specific Conditions

Pipeline Levee Repair Existing Site Characteristics (RM 15.4-15.6, Right Bank)

The Pipeline Levee is named after the water pipeline crossing at the downstream end of the facility. The levee was originally built in 1962 by King County, and extends approximately 880 lineal feet along the right bank of the Green River at RM 21.9. The 550 foot facility segment examined for this report lies within land presently occupied by the Riverwood apartment complex, including part of a retention/detention (R/D) pond that was excavated during construction of the apartment complex in the early 1990s. In effect, excavation of this pond converted the original revetment into a levee segment. The levee was relocated and set back into a portion of this R/D pond during Phase 1 of this project, which was completed in August 1999. The Okimoto Revetment and Signature Pointe Apartments (including a child daycare center) lie upstream from the facility; the south terminus of S. Russell Road and the Meyers Golf Driving Range lie downstream. The opposite bank is occupied by S. Frager Road and undeveloped open space owned by the City of Kent intended for eventual park development.

The total channel width (facility top width) ranges from 120 to 180 feet, and the OHWM width ranges from 65 to 80 feet. The planform of the river within this reach is meandering; the facility repair site is along an outside bend. The project reach and adjacent reaches upstream and downstream show the effects of extreme channelization, bank hardening and floodplain filling to create roadways, residential and commercial buildings, parking lots, a bicycle trail, a golf course and other public and private infrastructure. Hydraulic controls at this site include levee confinement per se (including the Frager Road Revetment and the DD&J Packing Co. Revetment segments on the opposite bank), operation of the Howard Hanson Dam upstream by USACE and the historic diversion of the White River away from the Green River upstream from the site.

The streambed of this regime channel is composed of organic materials, silt and sand; no gravels, boulders or bedrock are present just upstream from the project, and just downstream from the SR-516 bridge, a shallow left bank encroachment created by relict bridge piers and/or footings is present. This side channel bar form is covered with gravels and quarry spalls displaced from the bankline upstream. Flows entering a pool downstream from this construction create a localized pool along the left bank, which tails into a right bank sand and gravel bar just upstream from the project. The facility is subject to episodic erosion, as evidenced by toe and bank scour along portions of the facility. These problems were exacerbated by the excessive steepness of the facility, which was locally corrected during Phase 1 of this project (see the description in Sections 8.3 and 8.5).

Prior to completion of Phase 1, over 90 percent of the riparian vegetation covering the riverward levee slope consisted of Himalayan blackberry (*Rubus discolor*) and reed canarygrass (*Phalaris arundinacea*). Modest amounts of willows (*Salix* spp.) were (and still are) present just upstream from the project site along the Okimoto Revetment bankline where they were planted during repair of this facility in 1994. The relative paucity of complex overhanging vegetation and tree canopy on the riverward side of the levee results in exposure of instream biota (including salmonids) to both predators and warm water temperatures, and deprives terrestrial wildlife of riparian habitat niches.

A 12 foot wide asphalt bicycle/pedestrian trail that occupies the 16 foot wide levee top was relocated up to 30 feet landward during the facility setback in Phase 1. Prior to Phase 1, the backslope vegetation consisted of a blackberries along the upper slope, and approximately two dozen small trees, mostly Cedar cultivars (*Thuja* sp.), Douglas fir (*Pseudotsuga menziesii*), and lesser numbers of willow (*Salix* spp.) and maple (*Acer* spp.) cultivars. that were established during landscaping of the adjacent apartment complex. As mentioned above, the facility backslope and trail were set back into the R/D pond in Phase 1. Concurrent with this action, all but three of these trees were relocated either to the top of the bank or to a narrow, mid-slope bench along the Okimoto Revetment immediately upstream from this site. While survival of a few of these trees appeared to be in question as of the end of the 1999, construction season, most appear to have survived transplantation, in part due to frequent watering during and following Phase 1 construction activities.

As mentioned above in Section 8.2, the stream channel has been straightened and simplified throughout this project site as well as extensive reaches upstream and downstream. As a result, the channel lacks generally lacks channel-diversifying obstructions or hard elements such as rocks or logs except for limited volumes of partially decayed LWD that survived snagging operations conducted early in this century. As a result, the instream habitat at this site can be characterized as a long, continuous, riprap-lined lateral scour pool. There is a minor riffle along the left bank upstream under the SR-516 that drops into a pool throughout the upstream half of the Okimoto facility. A second minor riffle is present in sediments tailing out of this pool along the right bank in the middle of the Okimoto facility less than 250 feet upstream from the Pipeline project reach. A large log is embedded into the left bank across from the project reach, along with partially decomposed pieces of LWD in the streambed. In addition, there are some dense clumps of willows and red-osier dogwood trailing into the water along the left bank. Except for these features, little hydraulic refuge or escape cover is available to upstream-migrating adult salmonids during the late summer, fall and winter months, or to juvenile salmonids during high, winter flows, compared to conditions in natural channels. The nearly complete lack of LWD within the project site is due to historic removal and vegetation management practices (including maintenance of the levee in an oversteepened condition) that suppressed the natural succession of riparian vegetation. Since this facility will eventually be reclassified as a levee in the USACE's PL 84-99 rehabilitation program, the future maintenance decisions here will potentially be subject to USACE maintenance requirements that require removal of all woody vegetation in excess of four inches dbh from the face slope of the levee fill prism. The GRFCZD is currently not implementing these requirements. Regardless of these requirements, the trees recently relocated on the top of bank and riverward bench of the Okimoto Revetment (which is not subject to PL 84-99 maintenance requirements) could eventually serve as future sources of LWD in this reach. The project design at this repair site includes sufficient bench areas riverward of the setback levee fill prism to allow for dense establishment of overhanging, shade producing trees and shrubs in a manner fully consistent with USACE landscaping guidelines for PL 84-99 eligible levees.

Habitat and Fish Utilization Surveys

Riparian Habitat: On October 4, 1999 King County and USFWS staff collected habitat data and surveyed fish utilization within an 83 meter long project reach, and a 65 meter control reach[1] just upstream from the Meeker Street foot bridge on the left bank upstream from the proposed Narita Levee repair project (see data forms in Appendix E). The river discharge that day was not recorded. The average flow in the project reach was three feet/second. The average flow in the control reach was 0.5 feet/second in a segment of lateral pool habitat and 0.3 in a segment of backwater habitat. Little native riparian vegetation was present along the banks of both the project and control reaches project due to historic vegetation management practices, including maintenance of the facilities in an oversteepened condition. Riparian cover was absent along both the project and control reach. Five percent of the project reach and 10 percent of the control reach had overhanging vegetation. Most of the lower bank riparian vegetation in both the project and control reaches consisted of blackberries and reed canarygrass. When the levee was relocated during Phase 1 of this project, the backslope, upper front slope and bench were left unvegetated pending completion of Phase 2 of this project. Within the project reach, the lower bank below the bench consisted mainly of blackberries and reed canarygrass, but a single clump of willows is also present. A grass-lined R/D pond and apartment buildings occupy the riparian area landward of the levee.

[1] This same 65 meter control reach was also designated as the control reach for the Boeing and Pipeline levee repair projects.

Instream Habitat: Within the project reach, a single 83 meter long primary habitat was identified, characterized as a narrow, relatively deep lateral scour pool. The control reach contained a 65 meter long primary habitat, characterized as a narrow, relatively shallow lateral scour pool. Two secondary habitats were identified in the control reach: a 54 meter long simple lateral scour pool with slow-moving water, and an 11 meter long lateral scour pool with slow-moving water terminating in a tertiary habitat, namely a backwater eddy. Instream cover in the project reach consisted of riprap along the entire bankline, and woody debris along two meters of bank line, in addition to the riprap. Instream cover in the control reach consisted entirely of riprap. The substrate in the project reach consisted of loosely embedded coarse sand. The substrate in the control reach consisted of embedded fine silt. The overall habitat complexity in the project reach was judged to be moderate because of the cover afforded by the indented riprap and woody debris. The overall habitat complexity in the control reach was judged to be moderate because the presence of a backwater eddy and indented riprap.

Fish Survey: No fish were seen in either the project or control reaches.

Future Surveys: Additional habitat and fish surveys are planned starting in February 2001.

8.3 Proposed Action

The primary goals of the Pipeline Levee Repair project are to (1) restore structural stability to a 550-foot segment of the Pipeline Levee damaged by toe scour and bank slumping during the 1995-1996 floods, and (2) improve instream and riparian habitat for salmonids and terrestrial wildlife.

Phase 1 of this project, which entailed setting back the damage levee slope, was completed in April, 1999. Phase 2, currently proposed for construction in the mid-summer between 2001 and 2003, will include (1) installation of large toe rock to replace riprap scoured out during the 1995-1996 floods; instream installation of 50 pieces of coniferous LWD (all but three of which will have intact rootwads) installed within the toe along the low bench and anchored with large toe rock; (2), installation of live willow and red-osier dogwood brush layers within all disturbed portions of the lower bank, and (3) revegetation of all portions of the site that were not previously revegetated during phase 1 of this project.

8.4 Purpose and Need

The purpose of this facility repair project is to ensure flood containment and erosion protection within a densely populated area of Kent. The level of containment is judged sufficient to withstand a 100-year flood event with additional freeboard mandated by FEMA. The area that would be affected by failure of this flood containment includes downtown Kent and other highly developed commercial, residential, industrial land uses and public infrastructure, to valley wall to the east and north to I-405 in Renton. Historical records indicate that a breach or overtopping of the flood containment system did occur in this reach resulting in extensive flooding of the above areas--which were largely undeveloped farmland--in 1965. Phase 1 of this project was undertaken due to concerns about the unstable front slope of this facility (1.3H:1V) and the fact that pond excavation landward of the former revetment in the early 1990's effectively converted it into a levee with high seepage and piping potential and questionable structural properties. These concerns were addressed in the 1999 Phase 1 setback reconstruction of this facility. The purpose of Phase 2 is to add instream and riparian habitat features at this site, and stabilize the facility toe.

8.5 Construction Activities

All construction activities have been and will continue to be performed subject to applicable federal, state, and county permit requirements and conditions, with the exception that current federal standards calling for wholesale devegetation of PL 84-99 non-federal levees will not be adhered to.

Pipeline Levee Repair Phase 1 (completed in 1999):

1. The following were brought to the site and staged on a daily basis as needed:
    - Straw bales for slope mulching
    - Silt fencing for perimeter siltation control
    - Crushed rock for control of soil pumping on exposed soils in heavy traffic areas
    - 2-1/2 inch minus crushed rock for construction ramps
    - 1-1/4 inch minus crushed rock for soil lifts
    - 5/8 inch minus crushed rock for staging areas and road shoulders
    - Washed pea gravel for filter berms and silt fence installations
    - Hand brooms, street sweepers, and wash trucks for control of sediments on paved traffic surfaces.

2. Temporary access ramps were excavated from the top of bank at the upstream and downstream ends of the project segment into the backslope area of the levee between the existing asphalt trail surface and the landward footprint of the new setback levee alignment within the apartment complex R/D pond.

3. A two by 14 foot horizontal slope drain was constructed with 2-1/2 inch angular rock over filter gravel to enable suitable drainage of any seepage that might accumulate near the toe of the newly set back levee backslope toe during future floods.

4. Clean, well graded soil was placed incrementally in lifts between the existing toe of the levee backslope and the new toe drain to create the newly set back levee fill prism and backslope. Imported fill soils consisted of ledge rock screenings from the Enumclaw quarry. The final slope cover layer (one to three feet thick) was composed of Groco-amended topsoil (from recycled stockpiles in Renton) to promote healthy growth of riparian shrubs, to be planted during the 1999-2000 plant dormancy season.

5. All disturbed soil surfaces were straw mulched on a daily basis for erosion control.

6. The new setback levee fill was brought to the levee crest elevation, compacted with two lifts of crushed rock bedding, and paved with a 12 foot width of asphalt to relocate the bicycle trail into the new setback levee alignment.

7. The old asphalt trail throughout the project reach was removed and exported to the Washington Demolition Co. for recycling.

8. A silt fence was installed along the full 550 feet of the project site five feet above the OHWM. The fence was keyed into place with a one foot high by two feet wide filter berm.

9. The failure area on the riverward side of the existing levee over the full length of the project site was excavated down to approximately five feet above the OHWM. The oversteepened levee

slope was excavated back to a 2.5H:1V overall slope angle. Soft, saturated peat and clay deposits encountered in the midslope during excavation were removed and backfilled with a six foot deep and 16 foot wide midslope buttress of clean pit run, and were covered with three feet of Groco-amended topsoil to create a secondary "stair step" bench and slope buttress approximately 10 feet above the OHWM. The remaining lower bench area was excavated up to 20 feet in width, to within five feet of the OHWM. The excavated material was exported to an approved disposal site (Pacific Topsoil in Kent).

10. All disturbed soil surfaces were hand seeded and straw mulched during the work. Coir fabric was staked over the lower slope areas above the lower bench. Finally, all these surfaces were hydroseeded immediately following completion of the above work.

Equipment Used: PC 225, 230 and 330 track hoes, 10 CY dump trucks, 18 CY belly dump trucks, asphalt paving equipment, pickup trucks, 1 ton flatbed trucks, 30' bed trash hauler, hydroseed truck, water truck, vibratory roller-compactor and D6 bulldozer.

Proposed Pipeline Levee Repair Phase 2 (inwater work to be completed between June 15 and August 15, 2001-2003)

Temporary Erosion and Sediment Control (TESC):

1. The following will be brought to the site and staged on a daily basis as needed:
   - Straw bales for slope mulching
   - Silt fencing for perimeter siltation control
   - Crushed or washed rock for control of soil pumping on exposed soils in heavy traffic areas
   - 5/8 inch minus crushed rock for staging areas and road shoulders
   - Pea gravel for filter berms and silt fence installations
   - Hand brooms, street sweepers, and wash trucks for control of sediments on paved traffic surfaces.

2. An undisturbed band of existing vegetation will be left intact along the waterline until excavation of failed or damaged toe buttress areas for installation of crushed rock bedding, toe rock, LWD anchor rocks, habitat embayments and LWD.

3. A turbidity curtain (see Figure 10.1 and Table 10.5) will be installed at the site prior to in-water construction.

4. All in-water construction will occur between June 15 and August 15 (or as otherwise authorized by permit conditions), between 2001 and 2003, to avoid extended periods of rainy weather and high river discharge, and to coincide with the period of minimum habitat utilization by juvenile and adult salmonids.

5. All paved traffic areas will be kept free from sediment accumulations by daily sweeping and washing.

6. Turbidity will be monitored at the construction site, at flagged sampling stations 50 feet upstream from the excavation area and 250 feet downstream from the excavation area to facilitate compliance with limits on turbidity set forth in Washington Department of Ecology Order No.

DE 97WQ-007 (February 24, 1997), and at a flagged sampling station located one-quarter mile downstream from the site.

<u>Construction Sequence; Toe and Bank Repair</u>

1. Stake limits of construction area at site.

2. Shape ramps to access construction bench completed in 1999, from both upstream and downstream of bench area.

3. Starting at the downstream end of the project, install the floating turbidity curtain in 175-foot-long increments to isolate the instream work area(s) from the flowing stream.

4. Starting at downstream end of the project, construct toe repairs in fifteen foot long (maximum) increments, as follows:

5. Starting at the downstream end of the project, clear and grub existing blackberries and reed canarygrass from the lower bank slope, above the OHWM, in 15 foot increments. Export these plant and soil materials to an approved disposal location (Pacific Topsoil site in Kent or King County Roads Division soil recycling center in Renton).

6. Excavate existing failed levee rip-rap and unsuitable subgrade materials from the lower embankment slopes, above the water surface elevation, in the same 15 foot increments. Export these materials to an approved disposal location (Pacific Topsoil site in Kent or King County Roads Division soil recycling center in Renton).

7. Excavate failed or damaged toe buttress areas and unsuitable subgrade materials from below the water surface elevation for placement of new crushed rock bedding, toe rock, and LWD anchor rocks, and for excavation of the habitat embayments as shown on the plan drawings, working in the same 15 foot increments. Working from the embankment side toward the water's edge, leave an intact earthen "plug" at the riverward edge of the toe rock and embayment excavation area until the moment of actual LWD, toe buttress bedding, and toe rock placement in order to minimize turbidity.

8. Excavate and remove the earthen "plug" from along the water's edge, completing the excavation to depth as rapidly as possible. Immediately place 2-1/4" crushed railroad ballast and quarry spalls to stabilize the exposed riverbed and embankment soils, and to provide suitable bedding conditions for placement of LWD, anchor rocks, and toe rock. Complete this work within the same 15 foot increments.

9. Shape the habitat embayments and place LWD onto prepared bedding, as shown on the plan drawings. Place additional toe buttress rocks to firmly secure the LWD and toe buttress against undercutting erosion, working within the same 15 foot increments as above. Level the top edge of the rock toe buttress at a finished elevation approximately one foot above the OHWM, using light loose rip-rap, 2-1/2" crushed ballast, and 1-1/4" crushed gravel to provide a secure base for subsequent soil lifts and plantings.

10. Using the trackhoe bucket, gently place the additional coniferous LWD pieces into the water column, securing them along the bankline to the imbedded LWD with the chain attachments, and

to each other, starting at the downstream end and proceeding upstream. Overlap cut log ends riverward of the next rootwad protruding downstream and secure overlapped logs to each other with additional one-inch diameter anchor chain. The LWD should overlap in a downstream direction as shown on the plan sheets. To the maximum extent, anchoring of the LWD should seek to secure the logs below the OHWM as fully as possible, while minimizing the potential for individual logs to float up onto the bankline during flood events. Precise placement of individual LWD pieces will be accomplished under the supervision of the project engineer and the Senior Ecologist.

11. Proceed as specified above in 15 foot increments upstream, relocating the floating turbidity curtain as needed for subsequent portions of the instream work, to the end of the project repair reach.

12. Remove turbidity curtain.

Levee Slope Reconstruction

1. Following completion of all instream toe buttress construction and LWD placement, place a 3-inch lift of crushed quarry screenings the full length of the toe buttress along the top edge of the newly placed rock and logs around the margins of the habitat embayments. Seal all underlying voids and to create a secure base for subsequent placement of soil lifts and planting layers. Make sure the top surface of the screenings is located at a minimum of six inches above the OHWM elevation, in order to guarantee survival of the cuttings during the spring growing season.

2. Place an 8-inch layer of Groco-amended planting soil (≥20% Groco) along the full length of the bench adjoining the riverbank within the project area, extending for a minimum of eight feet in width. Place a layer of live willow and dogwood cuttings onto the planting soil layer as shown on the cross section drawings. The cuttings will up to 10 feet in length in order to extend the width of the prepared soil lifts. Place additional native riparian shrub and tree species into the exposed edge of the soil lift as specified in the planting schedule. Butt ends of the cuttings can be up to four inches in diameter; exposed ends of the cuttings will extend no more than one foot riverward from the finished slope. Cover the layer of cuttings with an additional 6 to 8 inches of planting soil and compact lightly with a single pass of the trackhoe. Once installed in this manner, each layer of cuttings will be embedded in a one foot minimum thickness of Groco-amended planting soil.

3. Import selected levee fill soils to the site and compact them in eight inch lifts to form fill layers between the layers of live cuttings. Each fill layer will be composed of three compacted soil lifts, extending the full length of the riverbank within the project area. Each finished fill layer will be wrapped with coir fabric for erosion protection.

4. Selected fill soils will be supplemented in lifts with crushed rock materials as noted above during periods of rainfall to provide for adequate compaction and to prevent pumping of mud in areas subject to equipment passage and truck traffic.

5. Alternate willow layers and coir wrapped fill and reconstruct the embankment slopes to finished grade as shown on the cross section drawings and plan sheet.

6. The embankment slope lifts will be brought as close as possible to finished grade and mulched with straw on a daily basis as needed during any anticipated periods of rainy weather.

7. Hydroseed any remaining disturbed soil surfaces following completion of all construction activities.

8. Stake slope areas subject to winter inundation with coir fabric over the completed hydroseed cover as needed to prevent winter erosion.

9. Plant middle and upper slope areas with potted native shrubs during the following plant dormancy season (October 1 through February 28) in accordance with planting plan and plant schedule shown on the project drawings.

10. Water plants and grass seed as needed, twice a week minimum, until the onset of fall rains.

Equipment Used: PC 225, 230 and 330 track hoes, 10 CY dump trucks, 18 CY belly dump trucks, pickup trucks, 1 ton flatbed trucks, 30' bed trash hauler, hydroseed truck, water truck, and D6 bulldozer.

Long Term ESC Monitoring

All stabilized slope areas will be monitored for signs of erosion during wet winter months and immediately repaired. Repairs can include straw mulching, straw mulch packing of incipient rills, gravel patching of incised rills, additional placement of topsoil, additional hand- and/or hydroseeding, placement of washed rock filter berms, and localized placement of additional silt fencing. The goal is to maintain a vigorous establishment of dense, deeply rooted erosion control grasses and native riparian vegetation on all disturbed slope areas at all times.

Long Term Project Monitoring

For details on long term monitoring of structural integrity, riparian habitat, instream habitat and fish habitat utilization monitoring, please refer to the monitoring plan in Chapter 11.

8.6 Construction Schedule

Inwater portions of this project are proposed to occur over a eight week period between June 15 and August 15, (or as otherwise authorized by permit conditions), between 2001 and 2003, which coincides with the anticipated window for instream construction established by the WDFW Area Habitat Biologist. However this window is subject to change due to the chinook and bull trout listings. Out-of-water work may continue until October 15. Potted plant installation will take place during the ensuing plant dormancy season.

9 PROJECT DESCRIPTION AND SITE SPECIFIC INFORMATION, FENSTER REVETMENT REPAIR

9.1 Project Location

The vicinity of the Fenster Revetment Repair is shown in Figure 9.1, and the project area and project site are shown in Figure 9.2. This project site is at RM 32.0 on the left bank of the Green River within unincorporated King County southeast of the City of Auburn. The site lies in the Southeast Quarter of Section 17 of Township 21 North, Range 5 East Meridian, approximately 600 feet north of Auburn-Black Diamond Road. The site can be accessed on foot from a cul-de-sac at the east terminus of 4th St. SE. The site is within an undeveloped parcel of land between Auburn-Black Diamond Rd. and the river owned by the City of Auburn Parks Department. At least two homes were recently removed from these lands, and the City plans to develop this area into a park in the future.

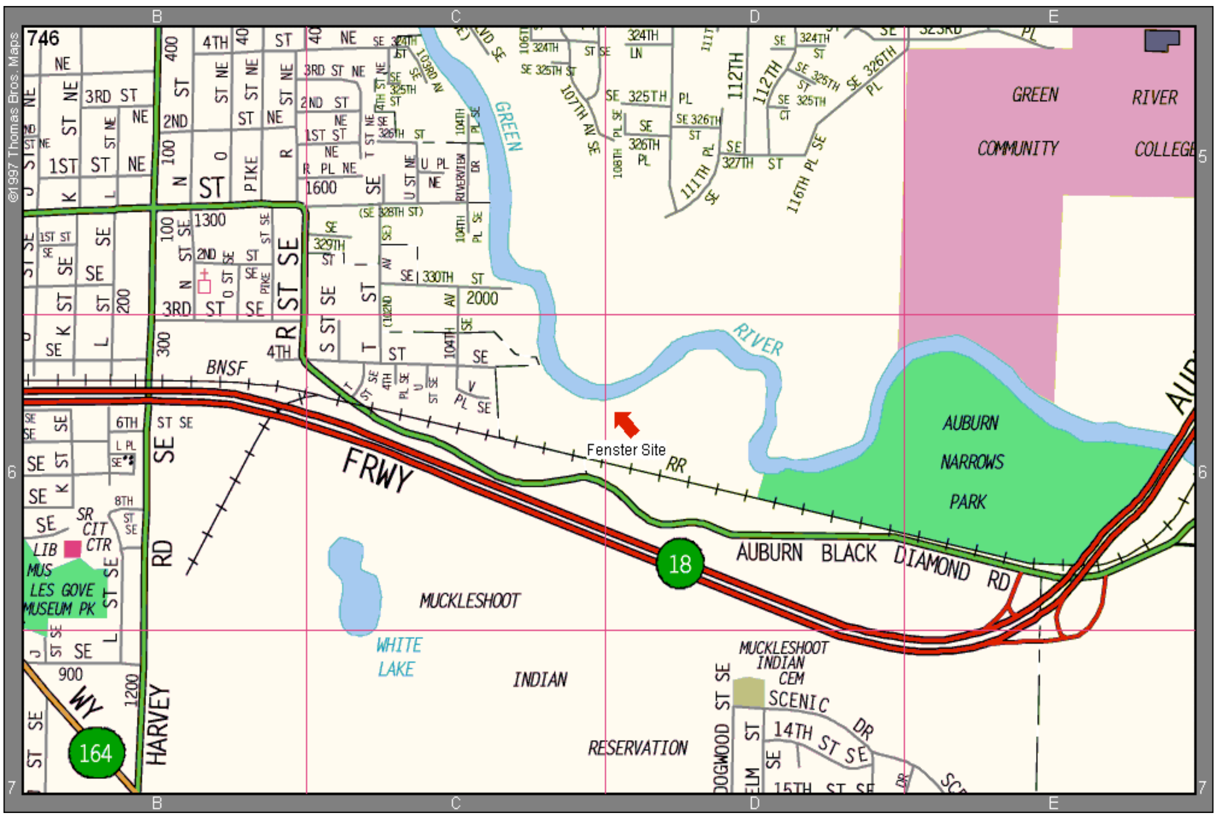

Figure 9.1 Fenster Revetment Repair Vicinity Map

9.2 Site-Specific Conditions

The 1900-foot long Fenster Revetment was built along the left bank of the Green River in 1962 in order to decrease bank erosion and prevent channel migration. The facility is composed entirely of angular riprap which has been colonized primarily by blackberries and relatively dense patches of willows along most of the revetment except for the upstream end, where scouring flows and bank trampling by recreational users have eroded out much of the face rock. The facility was intended to provide flood containment ranging from 10-year to the 25-year flood frequency, depending on location along the facility. At present it protects an undeveloped public park that borders the upstream and middle portions of the facility, and several single-family homes along the downstream end. Four additional homes are located several hundred feet away from the facility along Auburn-Black Diamond Rd. to the south. The facility top access width is approximately 14 feet. The front slope ranges from 1.2 to 1.75 H:1V, with a slope distance above OHWM of approximately 35 feet. Angular rock with a mean diameter of one foot extends from the toe of the facility to the top of bank, except for localized areas where it has eroded away. The native bank materials consist of silt and sand. Although all existing bank vegetation was removed during construction of the facility, patches of willows, small big leaf maples and alders have colonized along much of the facility's upper banks, along with invasive blackberries. The facility toe ranges from three to six feet below OHWM at a 1.5 H:1V slope. The toe rock ranges in size from two to three feet in diameter, although considerable quantities of smaller riprap have fallen over it from the slope above and deposited on the riverbed adjacent to the facility.

Examination of current topographic maps together with field reconnaissance indicate that the off-channel feature tributary to the Green River at the upstream end of the Fenster Revetment is likely an historic flood overflow channel. At present it receives local inflows from the seasonal high water table as well as backwater flows under high flow conditions during the late fall, winter and spring.

An 18 inch culvert near the upstream end of the 1900 foot long Fenster Revetment currently blocks fish passage at low to moderate flow levels between the mainstream Green River and the slough. Upstream from the project site, the slough flows through a wetlands complex on the valley floor, ultimately connecting with the river through a densely vegetated, mud-bottomed channel just south of the project site. This channel discharges to the river through the hung culvert, which penetrates a raised fill. This fill is a continuation of the revetment, which extends both upstream and downstream.

At present the culvert is suspended approximately six feet above the OHWM and the riverward end of it is thoroughly rusted and partially crushed, making it difficult for fish to access flooded off-channel refuge habitat when the slough mouth backwaters during moderate to large flood events. By removing the culvert and adjacent portions of the revetment, the rate at which the water level equilibrates between the river and the slough will increase, and the overall duration of inundation within the slough (a palustrine scrub-shrub/forested wetland) will likely decrease compared to current conditions. The amount of flood refuge and overwintering habitat available to juvenile salmonids during moderate to high flows will increase, and fish stranding will likely decrease as result of these changes. At the same time, the slough will drain more normally into the river as stage levels on the mainstem drop following floods. By adding LWD to the area near the mouth of the slough, escape cover and hydraulic refuge for fish will also increase over current conditions. The project will also add dense riparian vegetation in areas that are currently devegetated due to previous placement of riprap along the river bank and crushed rock along the top surface of the revetment. The project will not interfere with existing pedestrian access to King County-owned Auburn Narrows Park just upstream from the project. Future habitat restoration involving the Fenster Revetment will also be coordinated with the City of Auburn to relocate the existing pedestrian access landward of the top of the river bank at this location.

Habitat and Fish Utilization Surveys
Riparian Habitat: On September 29, 1999 King County and USFWS staff collected habitat data and surveyed fish utilization within a 57 meter project reach, and a 40 meter control reach just downstream from the project site (see data forms in Appendix E). The river discharge that day at the Auburn gage was 400 cfs. The average flow in the project reach was 0.42 feet/second within a segment of lateral scour pool habitat, and 0.55 feet/second within a segment of backwater habitat. The average flow in the control reach was 1.83 feet/second within a segment of lateral pool habitat, and 0.55 feet/second in a segment of backwater habitat. Some native riparian vegetation, including clumps of willows and small deciduous tree saplings, was present along the banks of both the project and control reaches due to abandonment of historic vegetation management practices in 1990. Riparian cover was present along approximately 28 percent of the project reach and six percent of the control reach. Eighteen percent of the project reach and 29 percent of the control reach had overhanging vegetation. Most of the lower bank riparian vegetation in both the project and control reaches consisted of blackberries. A gravel access road was observed at the top of the bank along both the project and control reaches. The land landward of the access road is undeveloped park land owned by the City of Auburn consisting of pasture and a corridor of immature deciduous trees along Pautzke Slough. The City regularly mows the pasture during the growing season.

Instream Habitat: Within the project reach, one primary habitat unit was identified, a 57 meter long, relatively deep lateral scour pool with slow-moving water. Within this primary habitat, two secondary habitats were identified, a 23 meter segment of simple lateral scour pool, and a 34 meter segment of backwater habitat. The control reach consisted of a 40 meter long primary habitat, characterized as a narrow, relatively deep lateral scour pool with slow-moving water. Within this primary habitat, two secondary habitats were noted: a 14 meter long simple lateral scour pool, and a 26 meter long lateral scour pool terminating in a tertiary habitat, namely a backwater eddy. Instream cover throughout the project and control reaches consisted of boulders. In addition, brushy woody debris was present along four meters of the control reach bankline. The substrate in the project reach consisted of slightly embedded gravel. The substrate in the control reach consisted of slightly embedded gravel and cobbles. The overall habitat complexity in the project reach was judged to be moderate because of the cover afforded by the indented boulders. The overall habitat complexity in the control reach was judged to be moderate because the indented boulders and brushy woody debris.

Fish Survey: In the project reach, four 100-200 mm trout and two sculpin were seen in the simple lateral scour pool; and one 100-200 mm trout, one 200+ mm trout and two sculpin were seen in the lateral scour pool with a backwater eddy. In the control reach, four 50-100 mm trout and eight 100-200 mm trout were seen in the simple lateral scour pool, and two 100-200 mm trout were seen in the lateral scour pool with a backwater eddy.

Future Surveys: Additional habitat and fish surveys are planned starting in February 2001.

9.3 Proposed Action

This proposed project entails removal of an existing hung and partially crushed culvert that blocks fish passage and water flow between the Green River and Pautzki Slough and during low and moderate flow conditions, removal of a 280 lineal foot segment of the Fenster Revetment which is penetrated by the culvert, and replacement of the existing revetment fill with a complex matrix of anchor rocks, LWD, soils and native riparian vegetation.

9.4 Purpose and Need

The purposes of this project are to (1) rectify a fish passage barrier near the upstream end of the Fenster Revetment, (2) reconnect the mainstem Green River to Pautzki Slough, which provides salmonid flood refuge and overwintering habitat, and (3) increase escape cover and hydraulic complexity along the left bank of the Green River at this location by installing habitat logs and native riparian vegetation.

9.5 Construction Activities

All construction activities have been and will continue to be performed subject to applicable federal, state, and county permit requirements and conditions.

Temporary Erosion and Sediment Control (TESC)

1. The following will be brought to the site and staged on a daily basis as needed:
   - Straw bales for slope mulching
   - Silt fencing for perimeter siltation control
   - Crushed or washed rock for control of soil pumping on exposed soils in heavy traffic areas
   - 5/8 inch minus crushed rock for staging areas and road shoulders
   - Pea gravel for filter berms and silt fence installations
   - Hand brooms, street sweepers, and wash trucks for control of sediments on paved traffic surfaces.

2. An undisturbed band of existing vegetation will be left intact along the waterline until excavation of failed or damaged toe buttress areas for installation of crushed rock bedding, toe rock, LWD, anchor rocks and LWD.

3. A turbidity curtain (see Figure 10.1 and Table 10.5) will be installed at the site prior to in-water construction.

4. All in-water construction will occur between June 15 and August 15 (or as otherwise authorized by permit conditions), sometime between 2001 and 2003, to avoid extended periods of rainy weather and high river discharge, and to coincide with the period of minimum habitat utilization by juvenile and adult salmonids.

5. All paved traffic areas will be kept free from sediment accumulations by daily sweeping and washing.

6. Turbidity will be monitored at the construction site, at flagged sampling stations 50 feet upstream from the excavation area and 250 feet downstream from the excavation area to facilitate compliance with limits on turbidity set forth in Washington Department of Ecology Order No. DE 97WQ-007 (February 24, 1997), and at a flagged sampling station located one-quarter mile downstream from the site.

Construction Sequence; Toe and Bank Repair

1. Stake limits of construction area at site.

2. Trench silt fence into riverbank slope, at lower limits of construction bench area, leaving an intact band of undisturbed vegetation downslope from the silt fence location, extending to the OHWM. Also install silt fence around landward edge of construction area.

3. Place pea gravel berm to anchor silt fence into trench.

4. Excavate upper embankment slopes to create and shape ramps to access construction bench excavation area, from both upstream and downstream of bench area.

5. Operating from the upper bank and from the ramps as needed, excavate the construction bench, landward of the silt fence.

6. Starting at the downstream end of the project, install the floating turbidity curtain in 175-foot-long increments to isolate the instream work area(s) from the flowing stream.

7. Starting at downstream end of the project, construct toe repairs in 15 foot long (maximum) increments, as follows:

8. Starting at the downstream end of the project, clear and grub existing blackberries and reed canarygrass from the lower bank slope, above the OHWM, in 15 foot increments. Export these plant and soil materials to an approved disposal location (Pacific Topsoil site in Kent or King County Roads Division soil recycling center in Renton).

9. Excavate existing failed levee rip-rap and unsuitable subgrade materials from the lower embankment slopes, above the water surface elevation, in the same 15 foot increments. Export these materials to an approved disposal location (Pacific Topsoil site in Kent or King County Roads Division soil recycling center in Renton).

10. Excavate failed or damaged toe buttress areas and unsuitable subgrade materials from below the water surface elevation for placement of new crushed rock bedding, toe rock, and LWD anchor rocks, in the same 15 foot increments. Working from the embankment side toward the water's edge, leave an intact earthen "plug" at the riverward edge of the toe rock and LWD trench excavation area until the moment of actual LWD, toe buttress bedding and rock placement in order to minimize turbidity.

11. Excavate and remove the earthen "plug" from along the water's edge, completing the excavation to depth as rapidly as possible. Immediately place 2-1/4" crushed railroad ballast and quarry spalls to stabilize the exposed riverbed and embankment soils, and to provide suitable bedding conditions for placement of LWD and toe rock. Complete this work within the same 15 foot increments.

12. Place LWD within the prepared toe trench bedding area at a 15 foot spacing, as shown on the plan drawings. Place additional toe buttress rocks to firmly secure the LWD and toe buttress against undercutting erosion, working within the same 15 foot increments as above. Level the top edge of the rock toe buttress at a finished elevation approximately one foot above the OHWM, using light loose rip-rap, 2-1/2" crushed ballast, and 1-1/4" crushed gravel to provide a secure base for subsequent soil lifts and plantings.

13. Using the trackhoe bucket, gently place the additional coniferous LWD into the water column, securing them along the bankline to the imbedded LWD with the chain attachments, and to each other, starting at the downstream end and proceeding upstream. Overlap cut log ends riverward of the next rootwad protruding downstream and secure overlapped logs to each other with additional one-inch diameter anchor chain. The LWD should overlap in a downstream direction as shown on the plan sheets. To the maximum extent, anchoring of the LWD should seek to secure the logs below the OHWM as fully as possible, while minimizing the potential for individual logs to float up, onto the bankline, during flood events. Precise placement of individual LWD pieces will be accomplished under the supervision of the project engineer and the Senior Ecologist.

14. Proceed as specified above in 15 foot increments upstream, relocating the floating turbidity curtain as needed for subsequent portions of the instream work, to the end of the project repair reach.

15. Remove turbidity curtain.

Levee Slope Reconstruction

1. Following completion of all instream toe buttress construction and LWD placement, place a 3-inch lift of crushed quarry screenings the full length of the toe buttress along the top edge of the newly placed rock. Seal all underlying voids and to create a secure base for subsequent placement of soil lifts and planting layers. Make sure the top surface of the screenings is located at a minimum of six inches above the OHWM elevation.

2. Excavate the bulk of the remaining revetment fill and remove the culvert from the historic swale at the site. Overexcavate slopes as shown on the drawings by a distance of six feet to allow for placement of clean gravels surrounding the logs, and for placement of willow layers and geogrid fills.

3. Install the log spillway into the excavated area of the historic swale and key into place with four to six foot diameter quarry stone. Dress the top edges of the log and anchor rock installations smooth and level with additional placement of quarry spalls, crushed railroad ballast, and quarry screenings to create a level surface for placement of the geogrid and planting layers. Bury the centerline of the swale excavation and surround the exposed logs to a depth of six feet with clean gravels, measuring approximately 1/4 inch to 4 inches in diameter. Departures from these gravel dimensions may be authorized in the field at the time of construction by the Senior Ecologist at the site.

4. Place an 8-inch layer of Groco-amended planting soil (≥20% Groco) along the full length of the bench adjoining the riverbank, and along both banks extending for a minimum of eight feet in width. Place a layer of live willow and dogwood cuttings onto the planting soil layer as shown on the cross section drawings. The cuttings will up to 10 feet in length in order to extend the width of the prepared soil lifts. Place additional native riparian shrub and tree species into the exposed edge of the soil lift as specified in the planting schedule. Butt ends of the cuttings can be up to four inches in diameter; exposed ends of the cuttings will extend no more than one foot riverward from the finished slope. Cover the layer of cuttings and potted plants with an additional 6 to 8 inches of planting soil and compact lightly with a single pass of the trackhoe. Once installed in

this manner, each layer of cuttings will be embedded in a one foot minimum thickness of Groco-amended planting soil.

5. Import selected levee fill soils to the site and compact them in eight inch lifts to form fill layers between the layers of live cuttings and potted plants. Each fill layer will be composed of three compacted soil lifts, extending the full length of the riverbank and the full extent of the recreated swale outlet, within the project area. Each finished fill layer will be wrapped with coir fabric for erosion protection.

6. Selected fill soils will be supplemented in lifts with crushed rock materials as noted above during periods of rainfall to provide for adequate compaction and to prevent pumping of mud in areas subject to equipment passage and truck traffic.

7. Alternate willow and planting layers with coir wrapped fill layers and reconstruct lower and upper embankment slopes to finished grade as shown on the cross section drawings and plan sheet.

8. The embankment slope lifts will be brought as close as possible to finished grade and mulched with straw on a daily basis as needed during any anticipated periods of rainy weather.

9. Hydroseed any remaining disturbed soil surfaces following completion of all construction activities.

10. Stake slope areas subject to winter inundation with coir fabric over the completed hydroseed cover as needed to prevent winter erosion.

11. Plant bench and upper slope areas with potted native plants during the following plant dormancy season (October 1 through February 28) in accordance with planting plan and plant schedule shown on the project drawings.

12. Water plants and grass seed as needed, twice a week minimum, until the onset of fall rains.

Equipment Used: PC 225, 230 and 330 track hoes, 10 CY dump trucks, 18 CY belly dump trucks, pickup trucks, 1 ton flatbed trucks, 30' bed trash hauler, hydroseed truck, water truck, and D6 bulldozer.

Long Term ESC Monitoring:

All stabilized slope areas will be monitored for signs of erosion during wet winter months and immediately repaired. Repairs can include straw mulching, straw mulch packing of incipient rills, gravel patching of incised rills, additional placement of topsoil, additional hand- and/or hydroseeding, placement of washed rock filter berms, and localized placement of additional silt fencing. The goal is to maintain a vigorous establishment of dense, deeply rooted erosion control grasses and native riparian vegetation on all disturbed slope areas at all times.

Long Term Project Monitoring

For details on long term monitoring of structural integrity, riparian habitat, instream habitat and fish habitat utilization monitoring, please refer to the monitoring plan in Chapter 11.

9.6 Construction Schedule

Inwater portions of this project are proposed to occur over a three week period between June 15 and August 15 (or as otherwise authorized by permit conditions), sometime between 2001 and 2003, which coincides with the window for instream construction established by the WDFW Area Habitat Biologist. However this window is subject to change due to the chinook and bull trout listings. Out-of-water work may continue until October 15. Potted plant installation will take place during the ensuing plant dormancy season (October 1 through February 28).

10 EFFECTS OF ACTIONS

The effects of these seven projects on baseline conditions were evaluated for chinook and coho salmon, bull trout, and bald eagle in accordance with guidance provided by NMFS and USFWS entitled, "Making Endangered Species Act Determinations of Effect for Individual or Grouped Actions at the Watershed Scale" (NMFS 1996), "A Guide to Biological Assessments" (NMFS 1999), and "A Framework to Assist in Making Endangered Species Act Determinations of Effect for Individual or Grouped Actions at the Bull Trout Subpopulation Watershed Scale" (USFWS 1998).

10.1 Environmental Pathways and Indicators

The National Marine Fisheries Services (NMFS) has prepared a matrix of pathways and indicators (Appendix B) designed to summarize important environmental parameters affecting ESA-listed, proposed and candidate salmonids and levels of condition of each parameter (NMFS 1996). Each of the six overall pathways (major rows in the matrix) represents a significant pathway by which actions can potentially affect anadromous salmonids and their habitats. The pathways are further divided into two types of indicators: (1) metrics with associated numeric values (e.g., "six pools per mile"), and (2) narrative descriptions of an overall condition (e.g., "adequate habitat refugia do not exist") for those indicators for which numeric data are unavailable or unreliable.

The columns in the matrix correspond to three possible levels of condition of the indicators: "properly functioning," "at risk," and "not properly functioning." For each indicator, there is either a numeric value or range for a metric that describes the condition, a narrative description of the condition, or both. When a numeric value and a description are combined in the same cell in the matrix, it is because accurate assessment of the indicator requires attention to both. Table 10.1 summarizes the environmental baseline and project effects of the environmental pathways and indicators.

Table 10.1 Environmental Baseline and Project Effects

PATHWAYS: INDICATORS	ENVIRONMENTAL BASELINE			EFFECTS OF THE ACTION(S)		
	Properly Functioning 1	At Risk[1]	Not Properly Functioning 1	Restore 2	Maintain[3]	Degrade[4]
CHINOOK, COHO						
Water Quality:						
Temperature			X		X	
Sediment/Turbidity		X			X	
Chem. Contam./Nutrients			X		X	
Habitat Access:						
Physical Barriers (Sites 1-6)	X				X	
(Site 7 - Fenster Revetment)			X	X		
Habitat Elements:						
Substrate		X			X	
Large Woody Debris (LWD)			X	X		
Pool Frequency			X		X	
Pool Quality/Large Pools		X		X		
Off-Channel Habitat (Sites 1-6)			X		X	
Off-Channel Habitat (Site 7 - Fenster Revetment)		X		X		
Refugia			X		X	
Channel Cond. & Dyn.						
Width/Depth Ratio		X			X	
Streambank Condition			X	X		
Floodplain Connectivity			X		X	
Flow/Hydrology:						
Changed Peak/Base Flows			X		X	
Drainage Network Increase			X		X	
Watershed Conditions:						
Road Density/Location			X		X	
Disturbance History			X		X	
Riparian Reserves			X	X		

1. These three categories of function are defined for each indicator in the Matrix of Pathways and Indicators (NMFS, 1996).
2. For the purposes of this checklist, "restore" means to change the function of an "at risk" indicator to "properly functioning," or to change the function of a "not properly functioning" indicator to "at risk" or "properly functioning" (i.e., it does not apply to "properly functioning" indicators).
3. For the purposes of this checklist, "maintain" means that the function of an indicator does not change (i.e., it applies to all indicators regardless of functional level).
4. For the purposes of this checklist, "degrade" means to change the function of an indicator for the worse (i.e., it applies to all indicators regardless of functional level). If a "not properly functioning" indicator may be further worsened, and this is noted in the following discussion.

The following discussion explains the rationale for scoring each of the indicators with respect to the environmental baseline conditions and the effects of the actions caused by these proposed projects.

Water Quality

- Temperature. Water temperature is perhaps the most studied physical parameter related to fish ecology and physiology. Intact riverine ecosystems in the Pacific Northwest are typically highly structurally diverse in terms of mainstem, off-channel and riparian habitats that exhibit numerous contiguous patches of cold water, especially in the summer months. Highly altered river systems lack structural complexity and contain relatively small and infrequent patches of cold water (McIntosh et al. 1995). Several recent reviews describe methodologies for determining optimal temperatures for a variety of fish species, including salmonids (Spence et al. 1996, Berman 1998, McCullough 1999, NMFS 1999). Natural and anthropogenic fluctuations in water temperature can induce a wide variety of behavioral and physiological responses in salmonids, including those involving feeding, growth, resistance to disease, reproductive success, competitive behavior, predator avoidance and migration. In addition, temperature also influences the productivity of lower trophic level algal and macroinvertebrate communities that support higher trophic level organisms, including fish (Bestcha et al. 1987). While water temperature varies both spatially and temporally in natural river systems, habitat heterogeneity allows fish to adapt to temperature changes by seeking out and occupying temperature refugia. Bjornn and Reiser (1991) have compiled information on the general range of upper, lower and preferred temperatures for several salmonid species. Chinook, coho, sockeye and chum salmon prefer temperature within the 12 to 14ºC (53.6 to 57.2ºF) range, while steelhead trout and bull trout prefer somewhat cooler water, ranging from 10 to 13ºC (50 to 55.4ºF) and 9 to 13ºC (48.2 to 55.4ºF), respectively. Lower lethal, upper lethal and preferred temperatures for rearing salmonids have been reviewed by a number of workers (Bell 1984, Bjornn and Reiser 1991, McCullough 1999). Low lethal temperatures for salmonid species range from 0ºC (32ºF) for steelhead to 3.1ºC (37.6º F) for sockeye; high lethal temperatures range from 22.8ºC (73 º F) for cutthroat trout to 28.8º C (83.3ºF) for coho. Lethal temperatures for bull trout have not been determined, but a water quality standards review by staff of the Oregon Department of Environmental Quality noted that (1) temperatures equal to or greater than 14ºC (57.2 ºF) are a barrier in the closely related Arctic char (*Salvelinus alpinus*), and (2) adult resident bull trout in Montana streams were found to be present at temperatures up to 18ºC (64.4 ºF), but at 19ºC (66.2 ºF) no bull trout were found to be present (Berman 1998, Pratt 1992).

  There is ample evidence that temperature is not properly functioning for either spawning or rearing chinook and coho salmon, and bull trout much of the time during the late summer construction window in the lower Green River (see Table 10.2). During mid- to late summer, water temperatures in the lower Green River within the action area frequently exceed the temperature criteria for Class A waters set forth in the state water quality standards (Chapter173-201A WAC), and sometimes climb into the upper lethal range for salmonids. For example, staff of MIT and the King County SWM Division recorded daily high temperatures ranging from 22 to 24.5ºC (71.6 to 76.1 ºF) at Bicentennial Park at RM 13.1 in Tukwila over a several day period during mid-July in 1995. Temperatures during the same time period were between 20 and 22.5ºC (68 and 72.5 ºF) at North Green River Park at RM 27.0 (Holly Coccoli, MIT, pers. com.). Similar exceedences of state water quality standards in the lower Green River are reported in Grette and Salo (1986), Fishery Sciences, Inc. (1984) and Caldwell (1994). Caldwell (1994) also estimated the number of hours during which temperatures in the Green River mainstem exceeded the state water quality standard for this reach of the river. At some locations within the chinook and coho salmon and bull trout action area, the cumulative total hours of exceedence ranged into hundreds of hours during late summer and early fall (see Table 10.3).

Table 10.2 Recorded Temperature Conditions Relative to Water Quality Standards, NMFS Habitat Criteria for Migration and Rearing and Potential Lethal Limits at Various Locations within the Mainstem Green River [2,3,4,5]

Location	Max. recorded temperature	NMFS Properly Functioning[1]	Exceeded ?	State WQ Standard	Exceeded?	Potential lethal for salmonids	Exceeded?
RM 69.0	>60 °F[4]	50-57 °F	Yes	60.8 °F	unknown	73-84 °F	unknown
RM 64.5	62-64 °F[4]	50-57 °F	Yes	60.8 °F	Yes	73-84 °F	No
RM 60.8	65 °F[4]	50-57 °F	Yes	60.8 °F	Yes	73-84 °F	No
RM 41.5	73.4 °F[4]	50-57 °F	Yes	64 °F	Yes	73-84 °F	Yes
RM 35.0	4.3 °F[4]	50-57 °F	Yes	64 °F	Yes	73-84 °F	Yes
RM 32.0	64-72.5 °F[5]	50-57 °F	Yes	64 °F	Yes	73-84 °F	No
RM 27.0	72.5 °F[4]	50-57 °F	Yes	64 °F	Yes	73-84 °F	No
RM 20.0	73.4 °F[4]	50-57 °F	Yes	64 °F	Yes	73-84 °F	Yes
RM 18.3	>64 °F[6]	50-57 °F	Yes	64 °F	Yes	73-84 °F	unknown
RM 14.0	>64 °F[6]	50-57 °F	Yes	64 °F	Yes	73-84 °F	unknown
RM 12.5	73.4-75.2 °F[4]	50-57 °F	Yes	64 °F	Yes	73-84 °F	Yes

[1]NMFS 1999
[2]Bjornn and Reiser 1991; Caldwell 1994; MacDonald et al. 1991
[3]USACE 1998
[4]Caldwell 1994
[5]Unpublished data from USGS cited in Caldwell 1994
[6]WDOE 1998

Table 10.3 Results of Temperature Monitoring Conducted on the Mainstem Green River in 1992[1]

Location	Maximum equilibrium temperature in July and August	Hours over 64°F	Percent of total time over 64 °F in August	Maximum equilibrium temperature in September
RM 41.5	73.4 °F	383	30%	66.2 °F
RM 35	74.3 °F	663	45%	68 °F
RM 27	72.5 °F	621	46%	ND
RM 20	73.4 °F	839	57%	68 °F
RM 13	73.4-75.2 °F	1140	71%	68 °F

[1] From Caldwell 1994
ND=No data

The optimum temperature range for upstream migration of chinook salmon is between 49 and 57.5°F (Bell 1986). High temperatures increase the metabolic rates of fish and result in greater energy expenditures. In some cases, adult fish migration blockages have been observed, and the death of some individuals has been observed in fish populations subjected to extreme temperatures (Bell 1986; Rod Malcom, MIT, pers. com. 1994). Lethal levels for adult salmonids vary according with respect to factors such as acclimation temperature and the duration of the temperature increase, but they are generally in the range of 73 to 84 °F (Bjornn and Reiser 1991; Caldwell 1994).

Although the upper Green River is not listed on the 1998 Washington State 303(d) list for temperature violations, water temperatures of inflow to HHD generally exceed the Class AA standard of 60.8°F at some point in most years (USACE 1998). This, coupled with high summer temperatures recorded at numerous locations below HHD (see Table 10.2) indicates that temperatures in excess of the preferred range for salmonid rearing and spawning is a widespread problem within the Green River, and thus could delay upstream migration of adult fish not only within the action area, but far upstream as well. The existence of long duration high summer temperatures throughout the Green River mainstem as far upstream as HHD strongly suggests that a thermal barrier may block bull trout migration throughout the action area during much if not all of the summer construction season.

The main reasons for these observed temperatures appear to be exacerbation of natural summer low flow conditions by surface and ground water withdrawals within the basin, and lack of shading of tributary streams and the mainstem from the headwaters to the estuary as documented in King County, 2000. This extreme lack of shading adjacent to the channel is especially prominent in the lower portion of the chinook and bull trout action area (see Figure 1.1). Vegetation is absent along the lower Green river due to agricultural activities, construction of roads (including flood control facility access roads) at the top of the bank along miles of river, and residential and commercial development. Along many miles of bankline, establishment of mature stands of native riparian vegetation is impeded by the existence of oversteepened bank slopes subject to constant toe and bank sloughing. About the only species that can persist under such conditions are herbaceous weeds such as reed canarygrass and blackberries, whose presence would greatly inhibit establishment of trees and shrubs even if adequate toe support existed. Finally, on both non-federal (PL 94-99) and federal (Section 205) levees enrolled in USACE levee maintenance programs, establishment of trees in excess of four inches dbh is prohibited. King County plants native riparian shrubs during its flood control facility repair projects, but is still subject to USACE maintenance requirements that require periodic removal of this vegetation.

The proposed projects will not affect existing summer water temperatures on the lower Green River over the short term, although it is possible that summer temperatures may decrease slightly in future decades as a result of improved shade provided by trees and shrubs planted within these project sites, especially in combination with maturation of similar plantings previously installed between 1990 and 1998 along several thousand lineal feet of riverbank at project sites with similar characteristics to those addressed in this BA.

- <u>Sediment/Turbidity</u>. Guidance for application of the matrix states that in a properly functioning system, gravelly sediment provides suitable substrate for salmonid incubation, food source production and cover from predators in moderate-gradient river reaches (NMFS 1999).

However, it is important to note that while this guidance was initially developed for use in streams in forested watersheds where excessive sedimentation may be problematical, the streambeds of low-gradient, Palustrine river channels such as that of the lower Green River are typically composed largely of fine sediments (pea gravel, sand and silt). Sediment released within the action area, as well as the much larger volumes of sediment from upstream sources such as landslides and forest practices typically settles within the low-gradient channel between RM 26.0 and the estuary. In order to consider the extent to sedimentation and turbidity can potentially harm listed salmonids and damage instream habitats present within the action area some discussion is needed of the biological and physical context in which these impacts should be considered.

<u>Biological Effects of Sedimentation and Turbidity</u>: The effects of fine sediment on aquatic life have been studied intensively for more than six decades, both in situ and in the laboratory (Everest et al. 1987). Laboratory studies have demonstrated potential negative effects of fine sediment on survival and emergence of salmonid embryos and alevins, on the growth of salmonid fry and on aquatic macroinvertebrates. However, there are significant difficulties in extrapolating these findings to the field. Many of the laboratory and field survival studies have found an inverse relationship between levels of fine sediment and salmonid reproductive success (Terhune, 1958, McNeil and Ahnell 1964, Dakin 1965, Cooper 1965, Wickett 1954, Alderdice et al. 1958, Shumway et al. 1964, Brannon 1965, Bjornn 1968, Phillips et al. 1975, Cederholm et al. 1981, Shelton and Pollock 1966). This topic is germane to the Fenster Revetment repair project because of its proximity of spawning habitat, but not germane to the six other projects addressed in this BA which lack spawning habitat. Laboratory studies have also shown that suspended sediments in extreme concentrations (>20,000 mg/l) can cause direct mortality of salmonids, but such concentrations are rarely found in nature or even downstream from construction sites such as these in flowing water. Noggle (1978) demonstrated that the tolerance of juvenile coho salmon to suspended sediment varies seasonally, with the highest tolerance in the fall when increased suspended sediment normally occurs in streams. Bisson and Bilby (1982) showed that groups of coho salmon parr acclimated to clear water (>0.3 NTU) and turbid water (2-15 NTU) in summer and showed significant avoidance when exposed to suspended sediments in excess of 70 NTU and 100 NTU, respectively. Sublethal effects of chronic suspended sediment on steelhead trout and coho salmon fry include reduced growth rate (Sigler et al. 1984) and inability of smaller fry reared in turbid water to compete for food and space with their larger cohorts reared in clear water (Sigler and Bjornn 1980). Noggle (1978) found that the ability of coho salmon fingerlings to capture prey organisms was lost at suspended sediment concentrations of 300 to 400 mg/l. Redding et al. (1980) studied the relationship between suspended sediment and stress in juvenile coho salmon and steelhead trout. They found that high levels of suspended sediment (2,000 to 3,000 mg/l) produced an initial mild stress response, but that fish adapted quickly. This study also found that fish previously exposed to sediment were more susceptible to *Vibrio anguillarum* infection than those that not been exposed to turbid water. Lake and Hinch (1999) investigated the roles of sediment angularity and concentration on stress and mortality in juvenile coho salmon using anthropogenically derived sediments that ranged from extremely angular to nearly round over a range of concentrations (starting at 40 g/L^{-1} , the gill abrasion threshold) in 96-hour experiments. Extremely angular sediments caused higher levels of physiological stress (e.g., decreased leucocrit). Sediment particle shape did not influence stress responses, and mortality was not observed below concentrations of 100 g/L^{-1},

A few field studies have documented major changes in salmonid spawning and rearing habitat from large-scale sedimentation due to forest management practices (Platts and Megahan 1975), and mass wasting (Coats et al. 1985). Field studies have also found a correlation between egg mortality and sedimentation of spawning gravels (Hobbs 1937, McNeil and Ahnell 1964, Koski 1966), redd site selection (Koski 1975), timing of fry emergence, fry quality and fry survival (Tagart 1976). A study by McCrimmon (1954) correlated the degree of bottom sedimentation in riffles with survival of Atlantic salon yearlings. Sedimentation in pools resulted in low survival of fry even when adjacent riffle areas were free of sediments.

Probably the most exhaustive study of the impact of sedimentation on salmonids is the one conducted in Carnation Creek on the west coast of Vancouver Island, British Columbia which documented modest increases (less than five percent) in pea gravel and sand, respectively, in spawning areas eight years after logging began in the watershed (Scrivener and Brownlee 1989). The study also compiled data on chum and coho outmigration as well as juvenile coho salmon in Carnation creek. Annual egg to fry survival of chum outmigrant fry was correlated with annual quality of spawning gravels, and size of emigrants also declined as gravel quality declined. Coho salmon egg-to-fry survival also decreased as spawning habitat quality decreased, but the average number of coho salmon smolts leaving the basin increased almost 50 percent.

Other field studies on the effects of sedimentation on salmonids have also yielded inconclusive results. For example, a study by Sowden and Power (1985) indicated that survival of rainbow trout fry in groundwater-fed streams in southwestern Ontario was more dependent on dissolved oxygen content and intragravel water velocity than on amount and texture of fine sediments. Investigations of pink and chum salmon egg and alevin survival in Sashin Creek in Alaska indicate that numbers of emergent fry in that system are more closely related to spawning escapement than sediment in spawning gravels (McNeil 1969). Burns (1972) showed mixed results in a study of logging effects on juvenile salmonids in northern California streams. While sediment increases were noted in all streams after logging, salmonid populations and biomass decreased in some streams but increased in others. Similar results were found by Moring and Lantz (1974) in the Oregon Coast Range following logging. Moreover, the latter study found that some streams in catchments that had been logged actually gained pool and riffle areas, while these habitats decreased in other systems, suggesting that factors other than sedimentation per se have a strong influence on channel morphology. Studies by Murphy and Hall (1981) in the Oregon Cascade Mountain Range found that canopy removal brought about by logging increased trout biomass even though streambed sediment also increased. Studies by Stuehrenberg (1975) and Klamt (1976) on summer and winter rearing habitat of juvenile steelhead trout and chinook salmon in Idaho found that juveniles of both species appeared to tolerate sediment, showing no significant differences in fish density in streams with substrates ranging from 26 to 52 percent fine sediment. When sediment was added experimentally to a riffle and pool in summer, fish density decreased in proportion to loss of pool volume. Density of age 0+ steelhead trout and chinook salmon decreased in the artificially sedimented riffle in winter, whereas age 1+ steelhead in the pool were not affected. Sediment entering streams after spring runoff was thought to have the highest potential for negative impacts on fish because it would stay in place until the next spring freshet. Moring and Lantz (1975) also showed increases in both suspended and deposited sediment in Needle Branch and Deer Creek, Oregon, after logging, but no concurrent reduction in coho salmon fry.

In summary, many laboratory and field studies have been conducted on the effects of sediment on reproductive success and population densities, but few if any have addressed the possible impacts of suspended sediment on behavior of individual species or interspecific interactions in mixed species populations of salmonids in natural environments. Fish in these laboratory experiments were not able to voluntarily leave the sediment rich water in which they were confined. Therefore, the results of these studies cannot be easily extrapolated to fish in natural aquatic ecosystems. Moreover, studies dealing with the effects of sediment in natural environments have been less conclusive because they have generally failed to isolate the effects of fine sediment from other environmental conditions (e.g., hydrology, geology, stream gradient and geometry, etc.) that also influence erosion and sedimentation, nor have they examined sedimentation impacts in the context of other factors limiting natural salmonid populations such as harvest management and ocean conditions.

<u>Physical Factors Influencing Sedimentation and Turbidity in the Lower Green River</u>: As discussed in Chapter 2, the sediment budget of the lower Green River has been grossly perturbed by the diversion of 75 percent of the historic sediment supply from the White and Black/Cedar Rivers in the early 20th century into the White and Cedar Rivers, respectively. Spawning sized gravels that used to exist down to at least RM 27.0 and in an alluvial fan formerly located at the mouth of the Black River at RM 11.0 are diminished because of disruption of coarse sediment supply and siltation due to lower water volumes and velocities resulting from these diversions. Hence, spawning and rearing habitat has decreased in quantity and quality compared to historic levels, and diversion of the White River has essentially ensured that such gravels cannot be fully replenished, even with anthropogenic gravel supplementation schemes such as those being contemplated for reaches upstream from RM 33 (State Route (SR)-18).

Much of the action area has a low gradient (< 0.5%) and the streambed substrate adjacent to six of the seven proposed project sites (excluding Fenster) is composed exclusively of sand and silt overlain with angular riprap that was end-dumped along the riverbanks and subsequently fell onto the streambed during and following construction of these flood control facilities in the, predominantly in the 1950s and 1960s. Downstream from RM 24.0 there are occasional limited areas of channel constriction downstream from bridges and old piers and pilings, where small pools and gravelly pool tail-outs exist, however none of these are adjacent to the lower most six project sites addressed in this BA. Upstream from RM 24.0, the gradient steepens slightly and patches of small and medium-sized (0.5 - 4.0 inches) gravels are present, including areas downstream from the Fenster Revetment repair site.

Another factor that has profoundly altered sediment transport in the middle and lower Green River is HHD. Though HHD is far upstream from the action area, it exerts profound effects on downstream habitats by reducing the 100-year floodflow from a historic flow of 32,000 cfs to the current maximum of 12,000 cfs at the Auburn gage, which corresponds to the historic 2-year floodflow. In effect, the dam impounds most of the coarse sediment and some of the fine sediment originating from channels and land surfaces upstream from the dam. Modeling suggests that between 6,500 and 19,700 tons of gravel per year that was formerly routed from the upper Green River to downstream areas is sequestered by the dam (USACE, 1998). As a result, gravel within downstream reaches to at least RM 58.0 (the upstream end of the Flaming Geyser Gorge) that is mobilized by moderate to large flood events is not replenished by transport from upstream reaches. Chronic scour of smaller sized gravels has downcut the main channel in the vicinity of Palmer by several feet, leaving behind a relatively immobile armor layer composed primarily of large cobble, boulders and bedrock, which are unsuitable as salmonid spawning habitat.

The operation of HHD has not only altered sediment transport, it also has profoundly changed the hydrology of the lower Green River. Floodwaters are released from the dam over for a much longer period of time following floods than under historic hydrologic conditions, resulting in the transport of high volumes of silt and sand-sized sediments during moderate and high levels of discharge from HHD. These materials contribute to a significant bedload of finer particles, which deposit on the bed of the lower river, and also on midslope benches within channelized reaches. These midslope bench deposits of fine sands and silts contribute to oversteepening of lower embankment slopes and chronic, episodic slumping. One of the results of this lower bank instability is the pervasive absence of woody vegetation even in areas where no devegetation or riprap has occurred for the past 20 or more years. It appears that rooting of woody plants cannot occur rapidly enough to keep pace with the chronic sloughing of these unstable fine-grained lower embankment soils. The net result is a continuing remobilization of fine sediments into within the water column throughout the chinook/coho/bull trout action area, and corresponding high levels of turbidity during most of the year except for the summer low flow periods.

This situation is further exacerbated when prolonged inundation of the fine alluvial materials composing most of the levees and revetments within the chinook/coho/bull trout action area during long duration high flow events is followed by unnaturally rapid drawdowns at the dam, which contributes to saturation slump failures of these seven facilities (and many others along the lower Green River) and releases of large quantities of fine sediments into the lower river. The vast majority of levee and revetment repair sites within the GRFCZD over the past decade have been at sites such as the seven addressed in this BA. These repairs typically include restabilization and flattening of mid- and lower bank slopes wherever space to do this exists, thereby allowing reintroduction of native vegetation to these chronically degraded environments.

Due to levee and revetment confinement and operation the Howard Hanson dam, overbank flooding now occurs rarely on the lower mainstem Green River. As a result, almost all of the sediment produced from natural erosion and human-caused activities including toe excavation during these projects, either settles out within the main channel of the lower Green River, or, during peak flow events in the winter and spring, is conveyed into Elliott Bay. Fine sediment deposition into gravelly riffle areas downstream from the Fenster Revetment Repair site can reduce salmonid reproductive success by decreasing oxygen penetration into the interstitial spaces within redds, and/or by physically trapping incubating salmonid eggs and alevins. Fine sediment deposited downstream from the other sites covered in this BA will settle on top of similar materials on the riverbed downstream.

<u>Impacts of Project-related Sedimentation and Turbidity on Salmonids Within the Action Area</u>: Only one of the presently proposed projects, the Fenster Revetment Repair, is situated in a reach that contains spawning habitat. The other six sites contain rearing and transportation habitat for chinook and coho salmon. Although the seven sites contain transportation for bull trout, for reasons mentioned in the discussion in Chapter 2 of bull trout habitat requirements, it is unlikely that any of these sites contains spawning or rearing habitat for this species.

Probably the most important sedimentation/turbidity effect to consider is its direct effect on salmonids present at and less than a mile downstream from these construction sites during the instream excavation phase of these repairs. Release of turbidity during construction could adversely affect the delicate gill surfaces of salmonids, interfering with respiration. It could also decrease light penetration into the water column, making it harder for juvenile fish to locate and successfully consume food resources. It could also disrupt or delay upstream migration of adult salmonids, and/or cause juvenile salmonids to temporarily leave the area during instream construction activities. Fine sediment may also fill pools downstream from all of the project sites, thereby decreasing the rearing habitat pool volume downstream from all seven project sites at least until the first freshet in the fall. Fine sediment deposition could also disrupt benthic invertebrate production downstream from the Fenster Revetment Repair site, thereby reducing the local food supply for salmonids. However, benthic production at the other six sites would be unlikely to be disrupted because the existing riverbed substrate composition (sand and silt) typically very low populations of large macroinvertebrates (Gore 1978), and in any event would not be changed as a result of these projects because the riverbed is composed of similar materials.

Water quality sampling conducted in the early 1990s showed baseflow turbidity in the lower Green River at average levels of 5 NTUs (Caldwell 1994). Studies conducted in support of the TPU HCP incidental take permit state that turbidity in the lower and middle Green River is not generally limiting to fish, although it may limit other beneficial uses such as water supply and recreation. Certainly, turbidity impacts on salmonids are of great concern, especially during flood events (USFWS and NMFS, 2000). But to put things into perspective, consider the persistence of relatively robust chinook populations in several glacially-headed rivers in the Puget Sound ESU: the White, Puyallup and Nisqually (Pat Pattillo, WDFW, pers. com. 2000), and in rivers in Alaska (e.g., the Cooper River) where robust salmonid populations persist in spite of vastly higher and more prolonged suspended sediment loads during the late spring and summer than are ever likely to occur in the lower Green River because of these projects. A study conducted during the summers of 1972 and 1973 of the effects of granitic sand on the distribution and abundance of salmonids in artificial stream channels in Idaho found that steelhead trout and chinook salmon were not directly affected by the levels of sediment added to riffle sections, their abundance was indirectly affected by a reduction in pool volumes due to sediment inputs (Stuehrenberg 1975).

Another example of persistence of salmonid populations in spite of massive riverine sedimentation is that of rivers affected by volcanic events. Numerous salmonid-bearing drainages in Alaska and a few in the Cascade/Sierra mountains have been impacted in recent decades by volcanic eruptions that released massive quantities of flowing water and sediment into river channels emanating from glaciers and snowfields on the flanks of these volcanoes. Damage to riparian and aquatic habitats during such eruptions typically far exceeds even the most extreme sedimentation impacts that could conceivably occur at the project sites addressed in this BA. However, studies of the aftermath of such volcanic impacts indicates that salmonids and other aquatic species such as macroinvertebrates are capable of rebounding from such impacts (Dorava and Milner 1999). In the case of the 1980 Mount St. Helens eruption, steelhead trout initially avoided affected drainages, with widespread straying into other Columbia River tributaries. Electrofishing and spawning surveys conducted over several years immediately following the eruption determined that steelhead populations rebounded as the habitat recovered (Lucas 1986). An exception to this generalization was in the case of stream segments where heavy ash deposits smothered spawning beds (Hawkins et al.1994), but it should be noted that this may not be very pertinent to the lower Green River where salmonid spawning habitat is not present.

Another important topic related to sedimentation and turbidity impacts is the issue of why excavation below the OHWM is necessary. The reasons these projects involve toe excavation are as follows:

1. <u>Ecosystem Restoration Mandates</u>: Restoration of instream LWD has been identified as a vital ESA listed species recovery action by the WRIA 9 Habitat Limiting Factors and Reconnaissance Assessment Report (King County 2000). Rivers Section staff agree that installation of LWD at

these seven proposed project sites is a critical early action needed to restore salmonid habitat in the lower Green River. The GRFCZD maintenance program is currently virtually the sole source of LWD within the action area reach. Even though this LWD is not, strictly speaking, recruited from riparian areas, the process of adding LWD at these seven project sites, and dozens others within the action area where LWD has been added in the past, represents an appropriate and cost efficient holding action until land acquisitions and removal of buildings and infrastructure from the riparian zone can be accomplished and more wholesale channel and floodplain restoration—including reforestation of riparian areas—occurs. This process will take many decades or even centuries to accomplish. In the meantime, the authors of this report would argue that short-term sedimentation and turbidity impacts are a small price to pay to obtain the long term benefits of increasing the quality of instream habitat within the action area reach.

2. Permit Compliance: LWD is a typical condition of state Hydraulic Project Approval (HPA) permits needed for these projects (Phil Schneider, WDFW, pers. com., 1990). Permit conditions also require that LWD be installed so as to remain in place in 100-year flood events to ensure onsite habitat benefits. Indeed, Rivers Section staff have not observed such benefits in project locations (e.g., the Elliot Levee on the lower Cedar River in Renton and the Hamakami Levee on the middle Green River) where insufficiently anchored LWD has washed away. Pieces that wash away can provide benefits somewhere downstream, or wind up on bars and banklines that are dry part of the year. Another fate of unanchored LWD is its conversion to firewood by local residents onto whose properties the pieces deposit. In contrast, significant increases in salmonid habitat utilization have been documented in locations where LWD anchoring has remained secure, and especially where this has initiated and sustained additional LWD and small woody debris (SWD) recruitment, resulting in accumulations of wood in complex, pool-and-cover-forming jams (Peters et al. 1998).

   Successful anchoring of LWD requires either that significant portions of the wood involved be imbedded into the stream margin, or that the LWD be secured artificially to a buried or embedded anchor. To date, Rivers Section staff have used LWD with intact rootwads protruding from the facility toe anchored to (a) concrete "ecology" blocks buried entirely within the facility toe, and (b) large (four to six feet in diameter) angular toe rock as anchors for additional LWD positioned roughly parallel to the bank and secured with deck-lashing chain. More recently, whole quarry stones measuring four to six feet in mean diameter have been used as LWD anchors because they can double as toe rock and often have the original drill holes (installed at the quarry to facilitate the insertion of explosives) still present and penetrating through the stone. This allows placement of the anchoring chains directly to the rock, with the result that anchoring trenches do not have to penetrate as deeply into the bankline as do LWD with rootwad anchors. In short, because of the inherent buoyancy of installed LWD and permit requirements that mandate that installed LWD in the first place and that it remain on-site, and channel and land use constraints adjacent to the channel (roads, bridges, buildings, etc.) that prohibit the construction of artificial logjams similar to those installed by Snohomish County in rural settings along the S.F. Stillaguamish River, there is no other practicable way to secure LWD other than anchoring it to structures embedded within the toe.

   The preferred method of anchoring, where there is room for excavation, remains the embedding of at least 15 feet of a 25- to 30-foot-long log with the intact rootwad projecting below the OHWM into the channel margin. Where river depths allow, anchor logs are placed to pin additional logs underneath the protruding trunks, locked into place by the overlapping rootwads. This is the method of securing several existing small log clusters at the Segale Levee in 1996. In more shallow water conditions where stacking logs in this manner will not fit below the OHWM, additional LWD is secured to the embedded anchor logs with deck-lashing chain. This creates a dense matrix of overlapping whole logs and rootwads roughly parallel to the bank for the full length of the project. Such placement is intended to provide a variety of near-bank cover, substrate for aquatic insects, and velocity niches for a number of salmonid species and life history stages, including listed, proposed and candidate species addressed in this BA. Chain is preferred over cable because, unlike cable, if it fails it does not fray and become dangerous to river recreationists as does cable. Moreover, it is much easier to adjust or replace a chain segment than a cable segment in the event that an LWD secured in this manner becomes too loose or is lost altogether during a flood. The desired number of chain links can be tightened and reshackled, or a new piece of chain shackled onto the old chain protruding from the bank in order to replace missing logs or add additional logs at a project site.

3. Other Instream Habitat Benefits of Excavated Banklines: Construction disturbance below the OHWM seems warranted if it increases the variety and abundance of habitat niches for salmonids in the lower Green River over the long term. In addition to LWD placement mentioned above, another approach is to create localized water velocity refuges in locations where channel margins are "freed up" by setting back a historic flood control facility away from the previously oversteepened riverbank. This approach is proposed at the Pipeline site, where a 20-foot-wide bench has been excavated approximately four to five feet in elevation above the OHWM. Plans for toe stabilization at this site include the excavation of a series of shallow embayments into the riverward margin of the bench, thereby increasing the amount of shallow, low-velocity habitat for rearing juvenile salmonids over a range of low-flow conditions. The project drawings show these embayments as including a number of pieces of LWD anchored with large-diameter quarry stone to provide cover and substrate, and to help create a range of localized velocity gradients to support feeding and resting behaviors.

   Sediments exposed in the excavation of these embayments will be initially stabilized with a cover of clean washed gravels in sizes ranging from one-quarter inch to four inches in diameter. It expected, however, that flood currents will initially reshape these gravel deposits, and eventually localized infilling of river-borne silts and sands transported from upstream areas during winter flow events will soon cover these gravels to moderate depths. This expectation is based on observations by Rivers Section staff (A. Levesque, King County, pers. com. 1999; Ruth Schaefer, King County, pers. com.1999) of depositional patterns at the Signature Pointe Lower Revetment Repair site (RM 22.2-22.3, RB) where similar channel-margin habitat elements were constructed in 1996. At that site, existing erosional velocities are being increasingly dampened throughout the low bench adjacent to these embayments by growing stands of native willows, dogwood, Oregon Ash, and other inundation-tolerant riparian trees and shrubs. Another example of this phenomenon can be seen at the Okimoto Revetment (RM 22.0, RB) immediately upstream of the Pipeline Revetment. Since this facility was repaired in 1994 a dense overhanging stand of willows initially installed as live stakes along the stream margin has induced fine sediment deposition along the channel margin. This vegetative growth in response to the lower Green River sediment and hydrologic regimes appears to be consistent with reports in the literature of LWD-induced sedimentation that provide a substrate for establishment of early successional plant species (Bilby and Bisson 1988, Fetherston et al. 1995).

4. Streambank Stabilization: Instream toe excavation is also needed to create a series of artificial channel undercuts and overhanging habitat niches along the extremely steep bankline at the Frager Road Revetment Repair site. The proposed construction technique involves imbedding a

series of 14 60-inch-diameter concrete culvert sections at right angles to the bank into the reconstructed revetment toe, entirely below the OHWM in order to provide structural bearing support for the steep slope above. The newly stabilized bank would then be planted with layers of live native willow cuttings to reinforce the soils within the steep embankment. The series of culvert sections is intended to serve as structural "arches" that form a series of submerged, cavelike niches in the revetment toe. The design also includes anchoring of whole-tree LWD into the toe between each culvert, overlapping and covering the culvert openings. Additional LWD with intact rootwads will be installed longitudinally and anchored to the imbedded rootwads to entirely enclose the series of undercut habitat niches in a dense complex of overlapping, sheltering LWD. While this design would result in short-term disturbance along the bankline below the OHWM, over the long term there would be a significant reduction in the current condition of ongoing sedimentation into the channel due to frequent soil sloughing and slumping along the well-developed slope failure scarp present at this site. Stabilizing the bank in this innovative manner is intended to restore streambank stability at this site by allowing for establishment of woody riparian vegetation in an area where such vegetation has been precluded for many decades. It would also locally introduce LWD volumes consistent with, though not identical to, PFC levels at this project site. Until the planted trees mature, however, the project would only change site conditions from "not properly functioning" to "at risk," because of the length of time it will take to achieve LWD recruitment. Nonetheless, this represents a significantly positive change over current conditions.

Another, more conventional approach to bank stabilization, namely replacement of missing and/or undersized toe rock also entails toe excavation below the OHWM. The four-to-six-foot diameter rock used in these repairs, when placed on a secure bedding of railroad ballast, quarry spalls, and both heavy-loose and light-loose riprap, forms a toe buttress that firmly supports the revegetated slopes above the OHWM. Without such structural support, rapid erosion and slope failure during flood events is possible. Such erosion is likely even where slopes are otherwise thoroughly vegetated, as was experienced when a river meander moved some 1,200 feet into mature deciduous forest cover upstream just upstream from the Hamakami Levee (RM 36.2, RB) over a three day period in January 1990. At the sites addressed in this BA, any significant erosion or failure of the riverbank will not only release large volumes of sediment into the river, it would also destroy the newly planted riparian cover that is an integral part of these repairs. Moreover, even a minor failure compared to the one that occurred at the Hamakami in 1990 could compromise the flood protection function of the facilities addressed in this BA.

<u>Anticipated Extent of Project-Related Turbidity</u>: In order to understand the effects of instream construction disturbance on salmonids and their habitats, it is necessary to understand the baseline flow and turbidity conditions present within the channel during and following construction. It is also reasonable to consider both the overall amount of construction proposed within the OHWM at each site, the amount of this disturbance which is below the water surface elevation (WSE) at the time of construction, the amount of construction area being actively worked at any given time at each site, and the potential extent of overlap in construction activity considering all the sites together.

First of all, it is necessary to address baseline conditions for substrate and sediment in the project and action area(s) involved. Substrate is considered a habitat indicator in the matrix of pathways and indicators developed by NMFS (NMFS 1999). According to guidance promulgated by NMFS, substrate is considered "Not Properly Functioning (NPF)" if "bedrock, sand, silt, or small gravel [are] dominant, or if gravel and cobble [are] dominant, [and] embeddedness [is] > [greater than] 30%." It is obvious even to the casual observer that sand and silt dominate the substrate throughout the lower

Green River. As noted in the WRIA 9 Habitat Limiting Factors and Reconnaissance Assessment chapter on sedimentation (King County 2000), prior to diversion, the White River was estimated to have contributed roughly 75 percent of the total sediment load to the lower basin (Mullineaux 1970). Coarse gravels tended to deposit on alluvial fans and bars upstream from approximately RM 27 (Dunne and Dietrich, 1978). Southwest of Renton, valley floor deposits are composed of silt, clay, and fine sand interbedded with peat (Mullineaux, 1970). With the exception of coarse materials associated with a smaller alluvial fan that formed near the mouth of the Cedar/Black Rivers, these deposits of fine material formed the substrate of the lower Green-Duwamish River prior to the diversions of the White and Cedar/Black Rivers (Mullineaux, 1970) and still do form it. Therefore, it is unlikely that this sub-watershed ever provided important spawning habitat for anadromous salmonids downstream of RM 27.

Sediment/turbidity is also considered an indicator under the water quality pathway in the matrix. As discussed above, the lower Green River originally formed under conditions characterized by continuous inputs of fine-grained sediments from readily pulverized, heavily weathered siltstone and mudstone sedimentary formations in the Green River Gorge, glacial deposits throughout the middle and lower valleys, and, most spectacularly, the Osceola Mudflow extending about four miles downstream of Auburn (Mullineaux, 1970). The substrate and sediment conditions historically present prior to anthropogenic disturbance presumably represented PFCs. It should be noted, however, that these historic conditions are inconsistent with the numeric standards set forth by NMFS in the matrix. In light of this, it is appropriate to adjust the numeric standards in accordance with guidance promulgated by NMFS for use of the matrix (NMFS 1999).

Given the nature and properties of the fine-grained sediments ubiquitously present throughout the project areas addressed in this BA, it is not surprising that episodes of elevated suspended sediment transport and turbidity are frequently present. This fact is readily observable during all but extreme low-flow events, when moderate water clarity allows a rare glimpse of the riverbed. Water quality sampling by King County staff from 1996 through 1999, average non-storm turbidity at two locations in the lower Green River found that turbidity averaged four to five NTUs, with a peak measurement of 89 NTUs during a storm on December 28, 1998 (King County 2000). Non-storm TSS concentrations at the same sampling stations averaged eight to 11 mg/L, with a peak storm measurement of 114 mg/L in December 1998. Because of low gradient, the lower Green River is a settlement zone for fine-grained sediment from diverse upstream sources. Under mid-summer low flow conditions, it is not possible to walk on the riverbed, let alone operate heavy equipment along the bank without mobilizing fine-grained sediments from the streambed into the water column. On the other hand, because the low flows normally present at these times of year are just marginally below the depositional threshold for such sediments, they tend to settle out within a few hundred feet of the sediment mobilization zone.

The most intense sedimentation Rivers Section staff have ever observed emanating from river construction sites on the lower Green River has occurred when dragline equipment, operating from the top-of-bank, was used to excavate toe-slope areas. In such cases, plumes of sediment-laden turbid water were seen to have thoroughly dissipated within one mile downstream of the construction site (Andy Levesque, King County, pers. com. 1999). Far greater levels of precision and control are typically achieved using the track-mounted excavators proposed for use in the projects addressed in this BA. Operation of this equipment results in far lower levels of turbidity disturbance than those that typically occur when inwater work is done with a dragline.

The individual lengths and total length of the seven projects addressed in BA are shown in Chapter 1, Table 1.1. The depth of excavation below the OHWM at these sites varies, but is typically less than 10 feet, the maximum reach of the excavators that will be used. The depth of flow will also vary throughout the instream construction window, with water slightly below the OHWM elevation at the start of the construction season in mid-June, declining thereafter and stabilizing in mid-July through the mid-September (well past the end of the in-water construction season) at about two to three feet below the OHWM. Since site access needs to be developed down to the OHWM at several of these sites, one of the BMPs employed to minimize instream disturbance is to conduct bench excavation at each of the sites early during the construction window, and inwater work later in the summer when river stages are minimal. Because low water conditions are associated with lower water velocities, mobilization and transport of disturbed sediments is also at a seasonal low starting in mid-July and extending through mid-September. With instream work scheduled from mid-June through mid-August, the actual depth of disturbance within the active water column varies typically from three to eight feet, with four to five feet representing a reasonable average.

As shown in Table 10.4, the width of excavation into the bankline also varies below the OHWM, but at any given time at any given site, it will not exceed 20 feet of the bankline, the maximum width of the trenches into which LWD will be embedded. Excavation for placement of the 12 foot lengths of culvert into the channel margins at the Frager Road Revetment Repair site will also be limited to this width. A construction bench of this width is also needed for track-hoe access at the Boeing Revetment Repair site. In most locations within the Segale, Desimone, Narita and Pipeline Levee Repair sites, and at the Fenster Revetment Repair, the maximum width of excavation at any given time will be less than 10 feet to allow for large rock placement; no embedded LWD is proposed at the Segale or Desimone Levee Repair sites, therefore, the trenches can be relatively narrow.

Table 10.4 Length, Width, Depth and Total Volume of Excavation Below the Active Water Surface Elevation During Construction

Site	Length (ft)	Width (ft)	Depth (ft)	Volume (CY)
Segale	190	8	5	281
Desimone	1,300	8	6	2,311
Boeing	130	12	6	347
Frager	175	18	6	700
Narita	550	10	6	1,222
Pipeline	500	15	8	2,222
Fenster	220	15	5	611
TOTAL	3,065			7,694

If all the mud dug up in this process were simply dumped directly in the river, and it were to deposit on the riverbed within a one mile segment of the river downstream from each project site, it would cover an area totaling seven miles long and about 75 feet wide, or about 308,000 square yards. The depth of deposition over this area would therefore average out to about (7429/308000) = 0.024 yards = 0.072 feet = 0.87 inches. This sediment would be utterly indistinguishable in grain size, character, and origin from that already present on the riverbed (Mullineaux 1970). Considering that the mud-bedded lower Green River probably mobilizes its fine-grained bedload to depths of at least several feet during full flood discharge, any sedimentation impacts from construction of these projects would be well within the background variability of suspended sediment within the lower river even under this absurdly extreme example.

The question that really needs to be answered is how much of the disturbed riverbank material will actually "leak" back into the river from the original construction-caused mobilization zone. The construction methods proposed for use in these projects have been deliberately chosen to minimize impacts of this activity. At the start of the construction season, crews would be scheduled to first complete slope excavation at those sites needing access ramp construction, namely the Boeing, Frager Road and Fenster Revetments and the Segale Levee. Ramp excavation would continue until water levels drop to their seasonal lows, at which time instream work would commence. Due to funding limitations, it will not be possible to construct all these projects during a single construction season. Moreover, even if full funding were available, there are insufficient construction crews trained for this skilled work available to perform construction at all seven sites simultaneously. Therefore, it is reasonable to assume that track hoe excavation would occur at a maximum of four sites during any given time period. The next step will be installation of the turbidity curtain (see Figure 10.1 and Table 10.5) prior to any toe excavation.

Table 10.5 Turbidity Curtain Features and Use Guidelines

Description	A floating geotextile material that minimizes sediment release into a waterbody from upslope land disturbance or inwater excavation and/or filling.
Purpose	To provide waterbody protection from sediment generated by upslope land disturbance or inwater excavation and/or filling.
Applications	Freshwater and intertidal waterbodies where intrusion into the waterbody by construction activities and subsequent sedimentation is unavoidable.
Construction Guidelines	• Do not place turbidity curtain across the main flow of a significant waterbody. • Install prior to upslope land disturbance or inwater construction. • Use in accordance with drawings and specifications.
Maintenance	• Inspect daily to ensure continuous protection against sedimentation. • If repairs are required, follow repair kit instructions. • Following completion of construction, allow sediment sequestered behind curtain to settle fully before curtain removal. Remove curtain carefully to minimize turbidity.

Toe excavation is typically limited to only that increment of bankline readily accessible to the reach of the excavator--15 feet is the practical limit for this reach. Where log trenches or deeper toe buttress excavation are proposed, such as at the Boeing, Frager Road, and Fenster Revetments, and the Narita and Pipeline Levees, all excavation would first be performed from the landward side of the cut, leaving an intact berm of existing soils and riprap along the channel margins. Log, toe rock and culvert section trenches would be dug one at a time in order to minimize sediment release. Immediately following exposure, disturbed soils in the excavated trench bedded with crushed railroad ballast, quarry spalls, and light-loose riprap in order immediately to cover soils subject to inundation. Only then would the face of the riverbank slope be excavated for the final placement of logs and/or toe rock. Toe materials (large rocks and, in at some sites, LWD) would be placed within the full 15 foot width of the trench excavation along the bankline, after which the disturbed area will be immediately dressed with more crushed railroad ballast, quarry spalls, and light-loose riprap layers to cover and protect the exposed soils, and to serve as additional bedding for the toe rock and, in some cases, LWD and culvert sections. During this process, sediment laden water within the trench and along the face of the channel margin would be exposed to flow in the river, although the velocity of the water would likely be dampened by the turbidity curtain. Overall time of exposure for each such increment of excavation would be on the order of one-half hour to perhaps 45 minutes total, which is also a fairly accurate estimate of the time it takes for the water column to clear, although it should be noted that this time may increase because of entrainment of much of the suspended sediment landward of the turbidity curtain. With the flow in the channel averaging two feet per second under these conditions, under a worst case scenario the suspended sediments could travel as far as 2 * 45 * 60 = 5,400 feet downstream. However, this is a far greater distance of sediment transport than that actually observed at an extensive bank stabilization project completed in 2000 on the Snoqualmie River at RM 44.4-44.5, where the 90 percent of the sediment plume dissipated within 600 feet of the excavation zone. This is consistent with past visual observations on the lower Green River where plumes of sediment-laden water generated by construction were typically fully dissipated within several hundred feet of the construction project site location, at most (Andy Levesque, King County, pers. com. 2000).

It should be noted that because each excavation will be staged sequentially, each individual sediment plume will typically fully dissipate before initiation of subsequent disturbance along the bankline. Therefore, impacts associated with this activity will tend to occur in a pulsed, episodic manner, no more than five or six times total for each site in a given day. Between 4:00 p.m. in the afternoon and 7:30 a.m. the next morning, no water quality disturbance will occur. The discontinuous nature of the disturbance, and its diurnal character, allows plenty of time for affected salmonids to adjust their position within the river in response to instream impacts thus created, especially in light of the fact that juvenile salmonids typically migrate at night (Doug Houck, King County, pers. com. 1999).

While no actual measurements of the volume of sediment suspended into the water column of the flowing stream have been made to date, it would appear conservative to estimate that no more than two inches of sediment depth would be mobilized across the full area of the excavation surface. As discussed above, if the excavation surface were conservatively estimated at 15 feet by 15 feet, and the entire area is assumed to be exposed at the same time, this would amount to 4 * 15 * 15 * 2/12 * 1/27 = a total of five cubic yards of suspended material introduced into the river, at any one time. For the entire project, the total amount of sediment mobilized by inwater construction for the entire summer, under these assumptions, would be 3,025 * 15 * 2/12 * 1/27 = 280 cubic yards. During even modest flood events, assuming the same mobilization depth of two inches of sediments from within the channel itself, the river itself would transport some 3,025 * 75 * 2/12 *1/27 = 1,400 cubic yards of identical sediments from the same total length of reach, together with several thousand additional cubic yards of sediments in transport from upstream areas. Spread out over four miles of stream channel some 75 feet wide, depths of eventual deposition of the disturbed sediments, if uncontrolled, would be in the range of 280 * 27 * 12 * 1/75 , 1/5,280 = 0.23 inches, or less than a quarter inch of depositional depth. Again, this is likely a highly conservative figure, based on a number of tiered, worst case assumptions. Actual mobilization, transport, and deposition is likely to be far less than this amount, in part due to use of a turbidity curtain at each site.

Although these projects will locally and transiently increase fine sedimentation, they will not result in transport of larger-sized sediment particles because they will not change water volumes or velocities, and the bank materials that will be excavated are composed almost exclusively of fine soil particles. Release of fine sediment from these project sites will be controlled by application of strict TESC measures, and by carefully monitoring turbidity and temporarily stopping construction to insure that turbidity does not exceed permitted levels of 5 NTU above background.

In conclusion, over the short term, these project will result in modest and localized increases in water turbidity and downstream sediment deposition. Over the long term, however, these projects will result in significant, albeit localized, decreases in sedimentation due to a decrease in soil slumping and increased structural bank stability brought about by improved facility toe support and the dense vegetation (primarily willows along the lower bank line) that will cover these sites over time. In addition, fine sediments from upstream areas already suspended in the water column during higher flow events will actually deposit within these newly vegetated bank areas, thereby incrementally reducing downstream sediment transport. Thus transportation and rearing of chinook and coho salmon and coastal cutthroat trout should not over the long term be adversely affected by fine sediment concentration either in the substrate or in the water column. Because bull trout are especially sensitive to fine sediment, existing sediment conditions in the lower Green River already pose a risk for this species, and will probably continue to pose a risk. However, as discussed in Chapter 2, bull trout are not expected to use the lower Green River except possibly for transportation to and from saltwater.

<u>Consequences of Not Allowing Toe Excavation</u>: If short term sedimentation and turbidity impacts cannot be tolerated by regulatory agencies—including NMFS and USFWS, the following will happen:

1. Historic levees and revetments throughout the lower Green River will continue to be characterized by nearly uniform, smaller diameter riprap and quarry spalls, rarely exceeding two to three feet in mean diameter. The uniform, monotonous, nearly featureless extent of these materials below the OHWM will continue to provide relatively little in the way of fish habitat, as documented by Peters et al. 1998.

2. The existing local fast velocity regime near the bank will be unmodified, and the existing lack of resting and feeding opportunities for foraging juveniles as well has cover for upstream-migrating adult salmonids will continue.

3. The current condition of frequent small and medium-sized slumps and larger-scale failures will continue to generate sediment and turbidity impacts except during summer baseflow conditions.

4. If flood damages to these facilities worsen catastrophically, even more damaging flood-fighting measures, including end-dumping rock during severe floods may be necessary to prevent loss of life and limb in the event of catastrophic facility failures.

- <u>Chemical Contamination/Nutrients</u>. Properly functioning riverine ecosystems do not exhibit chemical contamination and are characterized by low to moderate levels of nutrients. High levels of chemical contaminants such as metals, hydrocarbons and pesticides reduce egg and alevin survival and are toxic to juvenile and adult salmonids. Even low concentrations of such substances can induce physiological stress, alter primary and secondary production and reduce biodiversity (Seiler 1989, Karr 1991, Nelson et al.1991, Norris et al. 1991). High nutrient loads can cause eutrophication of sluggish or stagnant waters, and increase primary and secondary production, leading to anoxia during extreme algal blooms (Warren et al. 1964, Bothwell 1989).

Non-ionized ammonia is toxic to eggs and juveniles at high concentrations. (Triska et al. 1984, Gregory et al. 1987, Bisson et al. 1992).

The lower Green River receives inputs of numerous nonpoint sources of chemical contamination and nutrients, including stormwater runoff from urbanized landscapes, nutrients (especially phosphorus and nitrogen) from agricultural areas and golf courses along the mainstem between Auburn and Kent, and in the Mill Creek/Mullen Slough subbasin, and fine sediment from runoff from heavily logged upper watershed catchments. Fine soil particles also enter the river from slumping and eroded riverbank surfaces within levees and revetments along the lower river. As a result, water quality in the lower Green River is at risk for chinook and coho salmon, cutthroat trout and bull trout.

Because the seven projects addressed in this BA consist of repairs to existing flood control facilities in landscapes that are already built out, no increases in current levels of land development are anticipated as a result of these projects. Over the long term, these projects are likely to result in modest and localized decreases in chemical contamination and nutrients due to (1) localized decreases in soil slumping and erosion, (2) localized deposition of river-borne sediments, and (3) increased localized uptake of nutrients by maturing native riparian vegetation installed at these sites, especially willows planted along the lower bank line. Thus migration and rearing of chinook and coho salmon are unlikely to be adversely affected by changes in chemical contamination or nutrients brought about by these projects.

The sensitivity of bull trout to chemical contamination and nutrients is less well documented than that of most other salmonids. However, habitat conditions in the lower Green River are already unsuitable for spawning and rearing of this species, and will likely continue to be at risk for the foreseeable future. However, bull trout probably migrate through the lower Green River to and from saltwater and will therefore pass through the action area more quickly than the other ESA listed fish species addressed in this BA. Therefore, they are unlikely to be adversely affected by changes in chemical contamination or nutrients brought about by these projects.

Habitat Access

- Physical Access. A number of workers have assessed juvenile salmonid behavior and habitat preferences during various times of the year. Riverine ponds and other off-channel habitats provide important winter refuge for juvenile salmonids, especially coho salmon and cutthroat trout (Peterson 1982a, 1982b; Peterson and Reid 1984; Hartman and Brown 1987; Brown and Hartman 1988; McMahon and Hartman 1989; Swales and Levings 1989), which typically rear in freshwater for longer periods than the other *Oncorhynchus* species. Movement into off-channel areas is triggered by freshets in the fall and early winter (Tschaplinski and Hartman 1983, Scarlett and Cederholm 1984, Jenks 1989). The major physical characteristics of overwintering areas for juvenile coho salmon are moderate water depths (>45 cm), slow water velocities (<15 cm/s), and cover such as logs, tree roots, SWD and cutbanks (Bustard and Narver 1975a, 1975b; Sedell et al 1982; Steward and Bjornn 1988; Taylor 1988; McMahon and Hartman 1989, Quinn and Peterson 1996). Backwater habitat is also highly utilized by chinook during the first month of rearing in the winter and early spring (McCain 1989), while steelhead trout tend to prefer faster flowing water in runoff streams (Cederholm and Scarlett 1982; Swales et al. 1988). Although bull trout are suspected to spawn to some extent in ground-water-fed areas, studies to date have not revealed the use of off-channel habitat by this species (Baxter and McPhail 1996).

Studies of survival of juvenile coho rearing in off-channel areas indicate that survival is enhanced by access to such habitats (Tschaplinski and Hartman 1983, King and Young 1986, Everest et al. 1987, Swales and Levings 1989).

As mentioned in Chapter 2, flapgates impede fish passage between the lower mainstem Green River and many of its remaining smaller tributaries and off-channel wetlands. While fish access is currently unimpaired at six of the seven project sites addressed in this BA, there is a partial blockage at the Fenster Revetment repair site. At low to moderate river stage elevations, a hung and partially crushed culvert at the upstream end of this facility blocks juvenile salmonid access to the outlet of Pautzke Slough on the landward side of the facility. For reasons discussed above, this passage problem probably has the greatest effect on coho salmon during the fall, winter and early spring when fish are usually unable to enter the slough and benefit from the flood refuge habitat it would otherwise provide if it were fully accessible. The culvert and the revetment itself also partially block egress from the slough during flood drawdown because any fish that do not exit from the slough at river stages matching the invert elevation would likely be trapped in the slough until the next flood, and could even die due to stranding and/or high water temperatures if they were trapped during the last spring flood. Brown et al. (1988) estimated that off-channel habitats contributed a sizeable proportion (up to 23 percent) of the total coho production during a two year study in the early 1980s in Carnation Creek in British Columbia. These authors also noted that inability of coho salmon smolts to emigrate from off-channel habitats and return to the main channel in spring may have reduced total salmonid production in one of the study years.

The proposed replacement of the culvert and a portion of the revetment by a more natural array of LWD will help ensure that fish can more easily access and exit from the slough over a broader range of stage elevations than is currently the case. While the project could promote faster drainage of the slough when floodwaters subside, this would restore a more natural condition than currently exists. It should be noted that given the pervasive change in the hydrologic regime of the entire river brought about by current operation of HHD, full restoration of the slough's hydrology is not possible by culvert removal alone. On balance, however, the project is likely to result in a hydrologic regime within the slough that better resembles conditions prior to revetment construction.

Habitat Elements

- Substrate. In a properly functioning river system, sediment and its transport from source to downstream reaches is an important process that affects and maintains salmonid habitat. Suitably sized, clean gravel provides a quality substrate for salmon egg incubation, food source production and cover from predators. When sediment recruitment and transport is disrupted or perturbed by impoundments, channel diversions, mass wasting and pervasive bank erosion, fish habitat degradation results. Chronic bank erosion of fine sediments and their instream deposition can reduce egg and alevin survival, reduce primary and secondary productivity , and interfere with feeding, behavioral avoidance and social organization (Bisson and Bilby 1982, Bert and Northcote 1985, Everest et al. 1987, Chapman 1988). Sediment from mass failures and landslides can result in these same effects, as well as fill in pools and induce channel migration (Beschta 1978, Cederholm et al. 1981, Everest et al. 1987, Swanson et al., 1987, Chapman, 1988).

Substrate is currently at risk for all salmonid species in the action area because of historic diversion of the sediment-rich White River, which decreased water volumes and velocities within the entire action area, thereby decreasing the coarse sediment supply to the lower Green River. Analysis of floodplain deposits suggests that the White River formerly supplied approximately 75 percent of the sediment to the river downstream from its former confluence with the Green River at RM 32 (Mullineaux 1970). Substrate is also currently at risk in the remainder of the action area due to numerous bank slumps and stormwater outfalls that introduce large volumes of fine sediment into the channel from eroded tributary channels affected by increased peak flows stemming from urbanization of headwater catchment areas. Over the short term, the proposed projects will maintain current substrate conditions, but as the installed vegetation matures, sediment trapping of fine sediment from slumps and runoff from upland source areas should increase incrementally at these project sites.

- Large Woody Debris (LWD). Instream LWD is a critical component of salmonid habitat (Swanson and Leinkaemper 1978, Bryant 1983, Harmon et al. 1986, Bisson et al. 1987, Van Sickle and Gregory 1990, Bilby and Ward, 1991, Gregory et al., 1991, Peters et al. 1998). While the Middle Green River contains much more LWD than the lower river, it is deficient of LWD compared to healthy river systems. A recent survey of the middle Green River between the SR-18 and SR-169 bridges, found only 376 pieces (29.6 pieces per mile) of LWD and three logjams (Fuerstenberg et al. 1994) within the survey reach, far below the 80 pieces per mile considered "properly functioning" according to NMFS (1999). Although no comparable survey has been conducted in the lower Green River, a recent survey of LWD between RMs 5 and 11 found an average of 9.5 pieces per mile, not counting the pieces deliberately introduced in association with bank stabilization projects (Pentec 1999). The frequency of LWD within the chinook/bull trout/coho action area probably somewhat exceeds this, but not by much. A river survey conducted by Rivers Section staff in 1994 confirmed that there are no logjams within the action area, and what little LWD exists is typically in the form of widely scattered single deciduous logs and relatively old, decayed, deeply embedded, coniferous pieces. It has been estimated that up to 80 percent of the riverbanks below SR-18 (Fuerstenberg et al. 1994) have been developed, with attendant removal of LWD sources. Due to the relative paucity of LWD further upstream in the system, and the pervasive lack of riparian forests along the lower Green River, current recruitment of LWD into the lower river is negligible.

  Inspection of the seven proposed project sites reveals that all of these sites except the reach immediately upstream from the Fenster Revetment are severely depauperate of LWD due to historic land clearing of riparian forests, snagging, channelization and channel maintenance practices. The LWD just upstream from the Fenster Revetment includes several deciduous pieces in an existing eddy pool formed by perpendicular flow impinging against the project site, and a mature, intact cottonwood log that spans the channel just upstream from the eddy pool that appears to have fallen into the river in the spring of 2000.

  Altogether, these seven projects will add a minimum of 230 coniferous pieces LWD of 18 inches minimum dbh and 25 feet minimum length, plus a minimum of 50 pieces of deciduous LWD, thereby modestly increasing volumes of LWD within the seven project areas. These projects will also providing for some degree of future LWD recruitment as the tree plantings mature. However, these projects will not fully restore LWD to properly functioning levels within the overall action area because of existing land use constraints, including trails, roads, bridges, and residential and commercial buildings, nor will they fully restore functioning riparian forests future LWD sources adjacent to the project sites.

- Pool Frequency. Pool frequency within the lower Green River is currently not properly functioning because natural elements such as LWD that contribute to the formation and maintenance of deep, structurally complex pools are largely absent due to human-caused alterations. Boulders and bedrock, which also form pools in steeper gradient streams, are not naturally present in the lower Green River because of its extremely low gradient. While detailed pool surveys have not been conducted at these proposed project sites, the affected habitats at five of these sites generally consist of elongated lateral scour pools up to 10 feet in depth situated on outside river bends. These pools are presently devoid of LWD and lined with riprap both along the toe of these facilities, and rock that has dislodged and fallen into the bottom of these pools. Two sites (the Frager Road and Fenster revetment sites) contain relatively large eddy pools with modest volumes of deciduous SWD. Thus because lateral scour pools and eddy pools already exist at these proposed facility repair sites, these projects will maintain the current pool frequency along the lower Green River. At the other project sites pool frequency is not expected to change because of permit and boater safety-driven restrictions on the volume and orientation of installed LWD.

- Pool Quality. Extensive changes in the mainstem river channel and throughout the valley floor have drastically reduced pools and other rearing habitats for migrating and resident salmonids compared to historic levels. Prior to these habitat alterations, abundant well-shaded pools existed in the lower river where adult salmonids held prior to moving to their upstream spawning grounds. Rearing juvenile salmonids would have been seasonally present in high numbers in the lower river and the lower ends of its tributaries. Now however, many deep pools and other water velocity refugia have been reduced by LWD removal and the pervasive placement of riprap from at least the mid-bankline (and in some locations from the top of bank) down to the river bottom, thereby deepening the channel and increasing water velocities (Dunne and Dietrich 1978). As a result of these changes in channel form the availability of shallow channel margins and off-channel habitats for all juvenile salmonid species has been greatly decreased in the lower Green River. Salmonid fry have a narrow tolerance of depth and velocity extremes as evidenced by a study on the Willamette River (Li et al 1984) and a more recent study on several rivers in western Washington (R. Peters, USFWS, pers. com., 2000) showed that juvenile salmonids avoid velocities greater than 11 cm per second, and are seldom found at depths exceeding 30 cm. Fish that transit through high velocity areas such as those that exist in the lower Green River during releases of floodwaters from HHD are subjected to high metabolic energy demands if they attempt to maintain their position within the current and defend territories. As a result, the majority of the action area, including each of the project sites, primarily consist of transportation habitat that is grossly deficient in high quality juvenile salmonid rearing habitat due to lack of cover and velocity refugia.

  Pool quality is extremely low within the chinook/bull trout/coho action area because of pervasive riprap lining the existing pools, and the lack of complex cover that would be provided by LWD and overhanging vegetation in a well functioning river system. In addition, the existing pools are lined with a thick layer of fine sediment and flocculent organic material that has settled in the slower velocity reaches throughout the lower Green River. The only locations within the seven proposed project sites where LWD is present in pools are the Segale Levee Repair site, where several clusters of coniferous log flow deflectors with rootwads were placed during a previous repair in 1996, and the Fenster Revetment and Frager Road Revetment repair sites, where, as noted above, a few pieces of deciduous LWD and modest volumes of small deciduous debris have naturally lodged. None of these three pools has significant amounts of overhanging vegetative cover, however.

These projects will result in modest, localized restoration of pool quality through addition of LWD in various configurations, including coniferous log flow deflectors with rootwads at the Boeing Revetment, Frager Road Revetment, Narita Levee, Pipeline Revetment/Levee and Fenster Revetment sites; coniferous logs with rootwads placed parallel to the bank with rootwads facing upstream at the Segale and Desimone Levees, Frager Road Revetment, Pipeline Revetment/Levee and Fenster Revetment repair sites; whole deciduous trees placed parallel to the bank with rootwads facing upstream at the Desimone Levee repair site; and one or both of these elements in combination with moderately complex arrays of logs placed in eddy pools at the Frager Road and Fenster Revetment sites. In addition, numerous coniferous and deciduous trees will be planted at the Desimone Levee, Boeing Revetment, Frager Road Revetment, Narita Levee, and Pipeline Levee/Revetment, and Fenster Revetment repair sites in order to provide for future recruitment of LWD into the river. The volumes of wood installed and trees that eventually mature at these sites will improve pool quality in the near and long term, but will not fully restore it to properly functioning levels due to the extensive and irreversible channelization of the river and urban levels of buildout within the adjacent riparian zone.

- Off-Channel Habitat. Off channel habitat is currently not properly functioning within the action area because of extensive channelization, bank hardening by flood control facilities, blockages of tributaries by flapgates, and the filling and conversion of off channel habitats to developed land uses. Even the few tributaries within the lower Green River that are not flap-gated pose passage problems to salmonids during low flow conditions because existing average surface elevations in the river are much lower than prior to the diversion of the White River. The only one of these projects that will affect such off channel habitats directly is the Fenster Revetment repair, where existing off-channel habitat will be made more accessible to fish. Therefore, at six of the seven proposed project sites, existing degraded off channel habitat conditions will remain unchanged.

  At the Fenster Revetment repair site, off-channel habitat will remain constant in quantity, but modestly increase in quality because the mouth of Pautzke Slough will be restored by removal of a portion of the revetment and installation of LWD to improve fish passage, low-velocity hydraulic refuge and complex escape cover. Short term adverse impacts on the slough are expected to be negligible because the slough mouth behind the revetment will be dry during construction. Coho salmon and cutthroat trout will especially benefit from the changed conditions because of their propensity for relatively long residence in freshwater and their tendency to overwinter in off-channel habitats along mainstem rivers (Peterson 1982a, 1982b; Peterson and Reid 1984; Hartman and Brown 1987; Brown and Hartman 1988; McMahon and Hartman 1989; Swales and Levings 1989). To a lesser extent, chinook salmon may also benefit from improved access to flood refuge habitat at this site (McCain 1989).

- Refugia. Refugia are habitats or environmental factors that convey spatial and temporal resistance and resilience to biotic communities impacted by biophysical disturbances (Sedell et al. 1990). Landscape features associated with refugia operate at various spatial and temporal scales and may include localized micro-habitats and zones generated by riparian structure, floodplain features, hyporheic zones, and ground water input as well as macro-habitat features such as spatially relevant reaches, tributaries, and subbasins (Seddell et al. 1990, Berman and Quinn 1991). Existing refugia are currently not properly functioning for all salmonid species because the riparian reserves and off-channel habitats at all these project sites are either highly disturbed or entirely absent. These projects will not modify existing refugia or recreate refugia that were historically present, except to the extent that installation of LWD and revegetation may locally and incrementally restore micro-habitats associated with riparian structure along the mainstem riverbanks. As mentioned previously in the physical access discussion above, the Fenster Revetment repair will improve the structural characteristics of and access to the mouth of Pautzke Slough, enhancing its value as flood refuge in the late fall, winter and spring.

Channel Condition and Dynamics

Before continuing with a discussion of natural channel condition and dynamics, the authors of this BA would like to make the case that stabilizing these existing facilities against erosion is a reasoned response to present land-use constraints. Reintroducing "natural" rates of channel migration and associated erosion of floodplain lands is not feasible until and unless other programmatic decisions are planned, funded and implemented to remove existing, developed land uses (roads, trails, bridges, residential and commercial buildings, etc.) from the lower Green River valley floor. Moreover, no studies to date have determined what a "natural" process would look like under these highly altered conditions. For example, no definitive analysis has been made of altered floodplain and channel-forming conditions and processes associated with the major changes in hydrology created through historic diversions of the White and Black Rivers away from the Green River and modification of flow peaks, durations, and frequency distributions through construction and operation of HHD. It has been estimated the new floodplain surface is at least seven feet lower than the former, historic valley floor floodplain elevation (Dunne and Dietrich, 1978). To date, however, there has been no deliberate assessment of what the restored channel conditions would need to be to attain PFCs with respect to rates of erosion, deposition, channel migration, sinuosity, meander frequency, meander amplitude, meander precession, floodplain deposition, or related process-oriented variables consistent the current, radically hydrologically altered situation. Thus Rivers Section staff believe that some "holding action" is inevitable and appropriate until such time as a deliberate plan is formulated to implement landscape changes that would allow restoration of more natural riverine processes compatible with the current altered condition of the river and its floodplain. To be successful, these landscape changes would require massive and prohibitively costly relocation of existing urban infrastructure. Therefore, a habitat-friendly method of toe-buttress construction with large stone and firmly anchored LWD emplacements securing a revegetated native riparian community on a stable, depositional bankline represents an incremental improvement over current conditions that is attainable as an interim step under these circumstances, and would not in any way preclude further restoration when the necessary information and funding becomes available. Finally, it should be noted that "PFC" does not mean "pristine" (NMFS, 1999), and that modest steps in a restorative direction are preferable to allowing the river to remain in its current degraded condition.

- Width/Depth Ratio. While the numeric criterion of 10 established by NMFS for this indicator appears to be appropriate for moderate gradient streams, it seems inaccurate for a large, low-gradient alluvial stream such as the lower Green River. Well-functioning riverine habitats in low-gradient alluvial reaches such as the lower Green River in pre-settlement times likely had a much higher width depth ratio. Evidence for this can be seen in the following description of the Green River valley by an early geographer: “Prior to 1906, the larger portion [of the river] flowed closely along the north side of the valley for two miles, when it turned sharply to the north. After flowing north for about a mile, during normal runoff it was divided into two or three channels but in flood time it was divided into a multitude of channels. These channels seemed to wander aimlessly over the valley …" (Thomas and Thompson 1936). The historic diversions of the White and Cedar/Black rivers as well as the gross channel alterations to the lower Green River have confined the channel within the action area, effectively narrowing the width/depth ratios of these proposed project sites to 10 or less. Thus, while the channel form is technically in accordance with NMFS criteria, this does not indicate that PFCs are present. Land use constraints prevent anything beyond a very modest alleviation of channel constrictions at the Desimone and Narita Levees and at the Pipeline Revetment/Levee sites, and preclude it at the other sites. Thus the proposed projects will essentially maintain the existing width-depth ratios.

- Streambank Condition. Streambank stability is currently not properly functioning at these seven project sites and at many other failing bank locations within the action area. The banks throughout the lower Green River are composed of undersized riprap that was placed by end dumping in oversteepened configurations over the native bank materials, which at most locations in are composed of alluvial sands and silts. As a result, the banks are highly prone to saturation slump failure during drawdowns following prolonged release of stored floodwaters from the HHD reservoir. Increases of fine sediments in the lower river over past decades have filled pools and the interstitial spaces of the few remaining gravelly reaches of the lower Green River, thus reducing salmonid reproductive success and the amount and quality of habitat available for rearing juvenile salmonids.

  The proposed projects will restore streambank conditions by decreasing the slope angle to the maximum extent practicable given existing land use constraints, thereby providing greater toe stability and decreasing the potential for large scale slope failures; and by increasing the volume of woody vegetation, thereby increasing soil cohesiveness and bank structural integrity. In addition, revegetation will induce greater volumes of sediment deposition onto setback benches and reconfigured slopes, which will in turn induce accelerated growth of native riparian species planted during these projects and those that colonize onto these sites naturally.

- Stream Buffers. Vegetated riparian areas, especially riparian forests, influence numerous processes such as flood routing, sediment trapping, nutrient intake, allochthonous inputs, LWD inputs, shade, stream temperature and structural bank integrity (Naiman et al. 1988, Gregory et al. 1991).

  Because of historic alterations and wholesale removal of riparian forests, the lower Green River within the action area is not properly functioning in terms of stream buffer conditions. Over 80 percent of the banks of the lower river are within parcels that have undergone riparian devegetation during conversion of riparian lands to agricultural, residential and industrial uses that currently preclude restoration of riparian forests. When levees and revetments were constructed, numerous active and historic meander bends were permanently cut off, and at some locations facilities were built on top of gravel bars in the active channel of the river. The primitive construction methods of these projects entailed the wholesale removal of all riparian vegetation and included placement of a thick blanket of riprap on the newly constructed facilities, which was replenished as needed during and following major floods. Some facilities remained relatively unvegetated due to aggressive maintenance involving active removal of colonizing native and non-native vegetation, while others underwent gradual deposition of fine alluvium that became colonized mostly by aggressive non-native species such as blackberries and reed canarygrass. Beginning in 1990, discontinuation of maintenance practices involving systematic devegetation lead to the formation of dense mats of mostly non-native herbaceous vegetation along most of the flood control facilities in the lower river, including these seven proposed repair sites. While reed canarygrass and blackberries are able to trap fine sediments to some degree, their shallow root structure makes these species ineffective in resisting saturation slump failures which contribute large pulses of fine sediment to the lower river. In addition, the presence of these species in monocultural or bicultural stands inhibits successional processes that would otherwise lead to reestablishment of riparian forests (albeit in narrow strips) that would eventually help shade the river, contribute LWD to the channel, and modestly function as wildlife habitat.

These seven proposed repair projects will not restore significant tracts of riparian forest, but growth of planted riparian trees and shrubs will modestly restore stream buffers at these sites over the next several decades. Riparian habitat restoration will be most significant at the Desimone, Narita and Pipeline sites where facility setbacks were previously accomplished. This will allow establishment of trees on low benches as well as on the middle and upper facility slopes. Secure toe buttressing resulting from installation of large toe rock and LWD will help ensure that the planted vegetation will not be lost through future erosion and slumping.

In 1986 King County and numerous other local, state, federal and tribal agencies began meeting on numerous occasions with the USACE in an effort to persuade the USACE to promulgate regional levee vegetation management standards in the Pacific Northwest that are compatible with salmonid habitat protection and restoration. So far, these discussions have not produced a fish habitat friendly result. The USACE asserts that levee vegetation management pursuant to their nationwide standard is a local, not a federal action, and therefore consultation with NMFS and USFWS is not incumbent on the USACE. NMFS staff recently affirmed that no federal nexus exists with regard to vegetation management on non-federal flood control facilities such as those on the Green, Cedar and Sammamish Rivers. In 1990 the King County Rivers Section discontinued maintenance in the form of wholesale removal of vegetation on revetments and levees not subject to federal vegetation management standards. At the same time, King County initiated planting of native vegetation at all GRFCZD repair sites (including those addressed in this BA), while limiting removals on federal levees to invasive, non-native species.

Long stretches of the Green River show little or no natural colonization by native species, even though no wholesale devegetation has occurred in some instances for over twenty years. This is likely due to the inability of native riparian species plantings to compete where invasive mono- or bicultures exist. Since 1990 staff of the King County Rivers Section have selectively removed exotic species while deliberately retaining native riparian plants in the hope that this practice will assist in restoration of a well-vegetated riparian corridor. This work is performed by King County Roads Division crews and/or private vendors who selectively mow invasive stands of exotic, non-native plants such as blackberries, reed canarygrass, knotweed, and Scot's broom along the top third of the bank (well above the OHWM). Hand removal of invasive, non-native and noxious weed species is performed by Jobs for the Environment (JFE) and Washington Conservation Corps (WCC) crews. Work orders issued for these activities always specify that no native woody-stemmed vegetation is to be mowed, pruned, or otherwise removed. While occasional operator error may occur, the net, long range impact of these activities is expected to be beneficial because of suppression of invasive plants while allowing the growth of native riparian species.

- Floodplain Connectivity. The lower Green River within the action area is not properly functioning in terms of floodplain connectivity. Logging, systematic removal of LWD, and conversion of the lower Green River floodplain to agriculture and ultimately to residential and urban land uses have dramatically reduced secondary channels, off-channel ponds and tributary channels that formerly protected salmonids from damaging floodflows in the winter and provided cool water refugia in the warmer months. In addition, diversion of the White River narrowed the floodplain downstream of RM 31.2, forming a new floodplain within the old channel (Perkins 1993). The new floodplain is at least seven feet lower than the former floodplain (Dunne and Dietrich 1978), and many of the smaller tributaries along the lower Green River are conveyed into the river through flap gates that are perched above the OHWM. As a result, many of the remaining off-channel habitats are effectively disconnected from the river.

  Six of these projects will have no effect on floodplain connectivity, although the Desimone, Narita and Pipeline levee repairs will increase flood conveyance and slow floodwater velocities by widening the high flow channel at these locations. The Fenster Revetment Repair will modestly restore connectivity between the river and Pautzke Slough landward of the facility. Removal of the failed culvert that drains the slough will increase juvenile salmonid access to flood refuge and rearing habitat within the slough during the fall, as well as make it easier for fish to travel from the slough to the river when flows subside in the spring.

Flow/Hydrology

- Altered Peak/Base Flows. The lower Green River within the action area is currently not properly functioning in terms of peak and baseflow conditions. It is likely that these hydrologic alterations have adversely altered the timing of discharge-related salmonid life cycle cues (e.g., migration), as well as changed the abundance and availability of food organisms related to timing of emergence and recovery after disturbance. In addition, within portions of the action area where relatively intact riparian forests are still present (e.g., just upstream and along the opposite bank from the Fenster Revetment), changes in the flow regime may have altered forest successional processes, including patterns of establishment and growth rates of cottonwoods and other important riparian species (Scott et al., 1999; Jeff Braatne, UW, pers. com., 1999).

  Hydrologic conditions in the lower Green River have been drastically altered by anthropogenic disturbance, much of it deliberately devised for flood control purposes. Following major flooding in 1906, the White River was permanently diverted from its former confluence with the Green near RM 30.85. Similarly, the Cedar was diverted in 1914 from its confluence with the Green near RM 11.11 to provide operating flows for the Ballard Locks. As a result, the present day Black River conveys into the Green/Duwamish River only the much smaller volumes from the Springbrook/Mill/Garrison Creeks watershed.

  In 1961, HHD was completed at RM 64 to impound all flows in excess of 12,000 cfs measured at the Auburn gauge near RM 31.3. The dam has reduced Green River flood discharges from historic highs of 28,000 cfs recorded in 1960 to the 12,000 cfs peak discharge value, roughly corresponding to the uncontrolled two-year recurrence interval for Green River discharge alone, absent White river and Cedar River inflows. Ironically, flood refuge for salmonids was likely much more available during the historically briefer periods of extreme floodplain inundation, due to much greater access to off-channel flood refugia than under present, long duration floodflows in the now almost totally confined channel downstream from SR-18.

Hydrologic alterations to low-flow conditions are also a fact of life for salmonids in the lower Green River. Abstraction of summer-season baseflows from the White River by TPU is likely the greatest impact to the system. A great deal of attention has been paid recently to augmentation of summer low-flow conditions by increasing storage in the early spring at the reservoir behind HHD. This practice, however, may have other undesirable impacts, such as mortality of outmigrant juveniles from the reservoir, and dewatering of redds in the early spring when the reservoir refill is initiated.

A comparison of lowest mean flow non-exceedence probabilities from before and after HHD construction indicates that the dam results in a lower frequency of extreme low flow conditions, and a slight decrease in the more likely levels of mean-flow discharge (USGS 1984). Concerns with hydrologic changes to the river are legitimate and important in restoration of listed salmonid stocks to self-sustaining, not to mention harvestable, levels. However, the proposed projects described in this BA will have no direct effect whatsoever on river hydrology. The sole hydrologic effect of these projects will be that flows in the Pautzke Slough behind the Fenster Revetment will rise and fall somewhat more quickly during and following moderate to large floods, however, this is expected to restore a more natural hydrologic regime within the slough.

Another question to consider, however, is whether or not the release of artificial freshets from HHD by the USACE during the construction period could negatively impact fish during inwater construction at these sites due to inundation and/or scouring of exposed log trenches at the OHWM bank elevation, and low benches and lower slope areas excavated above the OHWM. Most artificial freshets would be targeted to occur in the spring, before the summer construction window. However, it is possible that an occasional freshet could be scheduled during the summer construction season when baseflows are normally quite low. To prevent excessive erosion of exposed soil surfaces during such summer freshets, King County Rivers Section staff would communicate in writing with the USACE Green River Flow Management Committee prior to the start of the construction season to request advanced notification of planned freshets. In addition to notification, the 12 to 15 hour travel time of waters released from HHD would provide a full working day to effect interim stabilization of exposed soil surfaces by rapidly completing any log trench excavation and log installation currently in progress, and temporarily placing crushed rock bedding and light-loose riprap over the refilled log trench to resist erosion prior to the arrival of the freshet at any given site.

Under the proposed flow management strategy described in TPU's HCP, if unusually high inflows were to enter the HHD reservoir during the spring, releases would be capped at approximately 2,400 to protect incubating steelhead redds from scour. Although such discharges would result in downstream river stages above the OWHM, they would occur well before the construction season. The HCP also provides for baseflow augmentation during the late spring and summer. During the period from May 1 through July 1, baseflows would be augmented from the HHD conservation pool as needed to provide a gradual linear decline from 750 cfs to 400 cfs. The intent of low flow management during this time period (which overlaps the early part of the construction season) is to prevent incubating steelhead redds from being exposed as flows gradually decline as spring progresses into summer. In spite of the two week overlap between the tail end of this baseflow augmentation period and the start of the construction season, this range of discharge would be well below the 1,200 cfs required to fill the channel to the OHWM elevation, and even farther below the 3,000 to 4,000 cfs needed to inundate the lowest construction bench (four to five feet above OWHM) that could practicably be constructed at the

Segale, Desimone, Narita and Pipeline sites. During the remainder of the construction season, baseflows would be maintained at a minimum of 350 cfs during wet years, 300 cfs in wet to average years, 250 cfs in average to dry years and 250 to 225 cfs, depending on the severity of the drought in drought years.

In summary, the possibility of artificial freshets large enough to inundate active construction benches during the construction season is practically nil. The fact that Green River baseflows are extremely low during the summer is precisely the reason that the WDFW-permitted construction season is timed the way it is—to protect fish and water quality against erosion and sedimentation impacts.

- <u>Drainage Network Increase</u>.

  The existing drainage network in catchment areas draining to the lower Green River is not properly functioning due to significant increases in artificial drainage structures brought about by pervasive urban and residential development over the past several decades, especially in the valley cities of Renton, Tukwila, Kent and Auburn. Much of the existing drainage network in the urbanized portions of the basin consists of ditches, culverts, R/D ponds, stormwater pipes, flapgates, etc. The projects addressed in this BA will have no effect on the existing or future drainage network.

- <u>Road Density/Location</u>. The existing road density within the action area generally vastly exceeds three lineal road miles per square mile, thus indicating that the lower Green River watershed is not properly functioning with respect to this parameter. There are many valley bottom roadways, especially in the incorporated areas on the east side of the valley. The projects addressed in this BA will have no effect on the existing or future density or location of roads.

- <u>Riparian Reserves</u>. The existing riparian reserve system within the action area is not properly functioning because it is highly fragmented--less than 95 percent intact--, poorly connected and provides inadequate protection for instream habitats and refugia for sensitive aquatic species (King County 2000). Except for the Fenster Revetment repair site, the project sites described in this BA lack significant stands of riparian vegetation due to the existence of trails, roadways, commercial and residential buildings, flood control facility maintenance roads, and, in one case, a golf course, immediately adjacent to the top of bank. Far less than 25 percent of the modest amount of riparian vegetation that exists at six of these sites consists of mature stands of native riparian tree and shrub species (King County 2000) thus indicating that riparian forest reserves are not PFC at these locations. In contrast, the Fenster Revetment repair site has a maintenance access road at the top of bank, but landward of that a patch of disturbed, but still moderately functional scrub-shrub wetland and deciduous swamp are present surrounding the portion of Pautzke Slough adjacent to the project site.

  These proposed projects will modestly restore riparian habitat conditions to the extent possible given existing land use constraints at all seven project sites. In particular, riparian habitat will be improved dramatically at the three levee repair sites--Desimone, Narita and Pipeline--at which the levee slopes have been set back up to 40 feet and low benches have been created to enable revegetation with suitable riparian tree species in addition to willows and other shrubs. Over time this planted vegetation should begin to provide some degree of cover, shade, habitat for aquatic and terrestrial insects as well as disturbance-tolerant terrestrial wildlife species, and, ultimately, woody debris recruitment. However, due to existing land use constraints, it will not be possible to restore fully functional riparian habitats and refugia for aquatic species.

10.2 Direct Effects

Because juvenile salmonid outmigration in the Green River occurs primarily during the spring, it can be anticipated that most of the fish present in the vicinity of these project sites will be upstream migrating adults. Successful salmonid reproduction requires successful migration of both males and females to the spawning grounds, adequate lipid reserves to carry out redd excavation and defense, high gamete quality, successful embryonic development, and the survival of the offspring during downstream migration to saltwater. Since migrating salmon generally do not feed, delays during migration can deplete limited energy reserves, increase mortality, and reduce spawning success. Therefore migration delays can result in excess energy consumption and prolonged exposure to high water temperatures in the lower river, both of which could limit reproductive success, increase disease susceptibility and decrease the quality and quantity of gametes of affected fish.

The construction of a maximum of four projects at once will result in episodic, short term sonic disturbances due to heavy equipment operation, as well as water quality impacts during placement of toe rock and LWD (see the above sediment and turbidity discussion for quantitative estimates of the latter effect). With the exception of the Segale and Desimone sites, which are right across the river from one another, the sites addressed in this BA are so widely spaced that sedimentation and turbidity impacts during construction are not expected to translate downstream from site to site. Furthermore, due to the sequential nature of project construction tasks, only some of which actually expose the river to sedimentation and turbidity, it is highly likely that water quality disturbances at each site will actually differ in the timing of their occurrence during each construction day. Because of this, even a major unforeseen impact at one or more of the sites would not be likely to cause cumulative effects at a series of sites located miles downstream. For this same reason, it is unlikely that fish temporarily displaced form one site location would seek out another site subject to similar, simultaneous disruption.

Pulses of turbid water will be generated during construction episodes; however, every effort will be made to minimize turbidity within the log trench excavation zones by leaving an earthen "plug" at the riverward end of each trench until the moment of actual log insertion. In addition, best management practices (BMPs), including placement of a floating turbidity curtain to sequester silt entering the water from the construction area for the duration of inwater construction, use of straw mulch and erosion control fabric will be employed to mitigate such impacts as a part of a comprehensive construction monitoring program to be jointly conducted by well trained and highly experienced staff of the King County Roads Services Division and WLRD Rivers Section, including an Environmental Supervisor and a Senior Ecologist. Turbidity monitoring will be employed to maintain water quality background within the Washington Department of Ecology approved dilution zone of 250 lineal feet downstream from the active construction zone. If turbidity threatens to exceed this level, construction will be temporarily halted until turbidity levels decrease below the allowable threshold.

While the potential sedimentation and turbidity impacts of these projects are localized, intermittent, temporary in nature, and often concentrated along one river bank in the vicinity of the thalweg, the aggregated effect of doing several projects at once would be up to four separate locations could be experiencing similar localized, intermittent and temporary disturbances, none of which is anticipated to worsen conditions at any other site, at a given time. In short, the level of disturbance experienced by any individual fish or group of fish potentially present would not exceed that due to each site considered individually. The sole exception to this conclusion is early-migrating adult chinook that hold for long durations in the lower Green River could sequentially encounter several sites over the course of passage to upstream spawning areas. However, it is likely that the bulk of upstream migration will occur during cooler, darker evening and nighttime hours, when construction is not active. Construction would also cease for at least one day per week (Sunday), and possibly two days (Saturday and Sunday), also giving fish a lengthy respite from disturbance. Assuming that temporary relocation to alternate holding areas near each site occurs in response to such disturbance, it seems reasonable to expect that the sublethal stress encountered would not preclude successful migration and spawning.

In the past 10 years Rivers Section staff have conducted over 70 bioengineered levee and revetment repairs on the White, Green Cedar, Sammamish Rivers, and the Snoqualmie River and its large tributaries, many of which are very structurally similar to the projects addressed in this BA. To date, dead fish have never been observed downstream from any of these previous project sites. On the contrary, Rivers Section staff have frequently observed juvenile salmonids reoccupying active construction zones within minutes following clearing of turbid water (e.g., in time periods as brief as coffee and lunch breaks, as well as longer periods of down time waiting for trucks to arrive). In these situations, juvenile fish appear to be exploring the newly installed LWD and toe rock. The remarkable speed at which fish reappear in these newly altered environments seems to indicate that (1) juvenile salmonids do not relocate very far off site in response to noise, vibration, splashing and turbidity generated during episodes of instream construction, and (2) their aversion to remaining in the vicinity of these sites in spite of active disturbances is not strong enough to induce them to avoid instream construction zones for long periods following cessation of disturbing activities, e.g., for the remainder of the day.

On the lower Green River during the latter part of the construction season (typically August although in previous years fish observations during construction have been made as late as October), it is not uncommon to observe adult salmonids (initially chinook salmon, and later in the season coho salmon as well) actively migrating through the river before, during and after periods of inwater construction over the course of a typical day, as evidenced by large fish occasionally splashing in the water within the project reach and sometimes quite close to the project site. For example, actively spawning chinook were observed in the channel within 200 feet of the construction zone during repairs of the Hamakami Revetment (RM 35.6, RB) in September 1995 and September 1996 (Ruth Schaefer, King County, pers. com. 1999), and migrating coho salmon were observed relocating during the early morning hours across the channel and upstream to alternative holding areas during construction activities at the McCoy-Breda Levee Repair (RM 24.55-24.95, right bank, just upstream from Kent) in late September 1997 (A. Levesque and Ruth Schaefer, pers. com. 1999). In no case was mortality observed. At the latter site the fish ran across a shallow sediment bar in one foot of water to areas about four feet deep, and held close to the bankline along newly placed LWD embedded within irregular toe rock, just as they had prior to construction at their original holding site. At the Christian Brothers Levee Repair (RM 17.10-17.25, right bank in Kent) in 1998 and 1999, WDFW enforcement personnel were called to address poaching from a holding pool immediately downstream from the project site. One poacher was observed catching 10 chinook in a row from this pool during instream construction at this site (Mike Krenz, WDFW, pers. com., 1998-1999). These migrating fish seemed relatively unaffected by transient plumes of turbidity along the same bank from which the poacher operated. Rivers Section staff observed similar behavior on the part of fish holding in pools downstream from the Dykstra Levee Repair (RM 30.6, left bank, in Auburn) project in September 1995. In addition, adult migrants appeared to explore newly-placed LWD structures, and engage in prolonged redd-building activity along the margins of mid-channel bars immediately proximate to the instream construction area at the Dykstra Levee repair site, which was also a favorite site for anglers of every description. Sockeye and chinook salmon redd-building and adults holding over newly-excavated redds have also been observed immediately adjacent to several revetment and levee repair sites on the Cedar River (Ruth Schaefer, Nancy Faegenburg, John Koon, King County, pers. com., 1999).

Following construction, when streamflows rise during onset of the fall/winter rainy season, there may be additional downstream turbidity, but it should be noted that rising streamflows typically trigger accelerated upstream salmonid migration, helping move fish out of harm's way. In addition, surface erosion will be minimized by placement of coir geotextile fabric on erodible slope surfaces and hydroseeding immediately following construction. After the surficial (construction-related) fines are washed away, turbidity levels are anticipated to rapidly diminish, generally within hours of re-wetting. As the installed willow cuttings and upper bank plantings mature, the risk of turbidity should decrease from pre-project levels, given that these projects will address the oversteepened, failed and inherently slump-prone condition of the river bank at these seven sites within the action area. The long term effects of these projects with respect to erosion and sedimentation are anticipated to benefit chinook and other salmonids by installing LWD and stabilizing the river banks and levee back slopes with native riparian vegetation.

Bald Eagle

Four factors suggest that the effects of these proposed projects on bald eagles are negligible or discountable. (1) Documented bald eagle perching, roosting and nesting habitats are absent in the vicinity of all of the project sites. Several stands of large cottonwoods exist within the Fenster Revetment Repair project area where overwintering eagles could roost or perch, but construction at this site would be conducted in mid-summer, well before bald eagle utilization of these trees would typically occur. (2) Salmonid carcasses, which are a major attractant for overwintering bald eagles in the Pacific Northwest riverine habitats, would not be present at six of these sites because they are devoid of spawning habitat, gravel bars or LWD where carcasses would either be generated or accumulate from upstream sources. Salmonid spawning habitat is present within the seventh project area, that of the Fenster Revetment Repair, but all construction activities at that site would be completed before mid-August, the start of the chinook spawning season. Hence carcasses would not be present and bald eagle foraging would be unlikely during construction. (3) Based on observations by USACE biologists at construction projects on the Yakima River, bald eagle use of river areas is not noticeably affected by the presence and operation of construction equipment such as excavators and dump trucks (Michael Scuderi, USACE, September, 1998). The tolerance of bald eagles in urban areas for truck traffic is also evidenced by the fact that a pair of bald eagles has nested for several years in Discovery Park in Seattle, where frequent truck traffic to and from the adjacent West Point sewage treatment plant (STP) occurs. Successful bald eagle reproduction occurred even during the years when a major expansion of the STP was being constructed (Kate Stenberg, 2000, pers. com.). (4) Observers will be present onsite during construction to monitor bald eagle use. If disturbance is observed, construction will be halted until the eagles have left the area.

Chinook and Coho Salmon and Bull Trout

The proposed projects will have short-term impacts on water quality and fish behavior during construction; however, construction will be completed during the summer when water levels are low and water quality impacts can be minimized. All work areas except the riverward ends of the log trenches and portions of the facility toes where toe rock will be installed will be isolated from surface flows. In addition, BMPs, including placement of a floating turbidity curtain in order to sequester any observed plumes of silt throughout the duration of inwater construction, and all known and reasonable techniques (AKART) will be utilized to prevent erosion and control sedimentation in order to protect aquatic organisms. While temporary discharges of fine sediment can reduce the quality of spawning habitat, it is important to note that no spawning habitat is present at or downstream from any of these seven project sites. While chinook juveniles may be present in the action area during construction of these projects their numbers will be low relative to peak counts of outmigrating juvenile chinook typically observed in May. The inwater portions of these projects will be completed largely before the onset of the adult chinook salmon upstream migration season. As mentioned in Chapter 2, bull trout presence is considered unlikely (although not impossible) due to the typical summer temperature regime in the lower Green River during the construction season.

Juvenile chinook or bull trout migrating or rearing in the Green River could be impacted by the project through noise, turbidity, or other activity. Based on ten years of experience constructing these projects on all the large rivers in King County, juvenile fish typically move unknown distances away from project sites during episodes of active construction, and move back into the sites where they are visible amidst newly installed logs during even brief cessation of construction activities (e.g., during 15 minute coffee breaks). Following construction at the end of each day, juveniles (and presumably adults, if present, would likely move back into or pass beyond the project sites, thus ensuring continued fish passage during the late afternoon, evening and nighttime periods.

Over time, the LWD, shade trees and overhanging vegetation installed on the low benches installed at these sites will provide a modest amount of hydraulic refuge during winter flood events when velocities behind these woody obstructions and above these indented benches will be lower than those further out in the channel. These effects are considered beneficial**.**

10.3 Indirect Effects

Indirect effects are those effects that are caused or will result from the proposed action and are later in time, but are still reasonably certain to occur [CFR §402.02]. These facilities have existed for many decades. These proposed repairs do not entail facility expansion either upstream, downstream or waterward into the river channel. Therefore, these projects are unlikely to create conditions that will increase the number or incidences of future activities that could have effects on listed, proposed, or candidate species. For this reason no indirect effects are foreseen for chinook and coho salmon, bull trout and bald eagles.

10.4 Cumulative Effects

Cumulative effects are those effects of future Washington state or private activities, not involving Federal activities, that are reasonably certain to occur within the action area of the Federal action subject to consultation [CFR §402.02]. For the same reasons mentioned above, the proposed projects will not increase the number or incidences of future activities that could have effects on listed, proposed, or candidate species. For this reason no adverse cumulative effects are foreseen for bald eagles, chinook and coho salmon and bull trout. In fact, the cumulative effects of these projects will likely be beneficial because over time, the LWD, shade trees and overhanging vegetation installed on the riverbanks at these sites --especially on the three facilities with low benches--will increase the number of local river reaches that contain modest amounts of hydraulic refuge, overhanging vegetation, and shade.

10.5 Interdependent Effects

Interdependent effects are actions having no independent utility apart from the proposed action [CFR §402.02]. These proposed projects will not precipitate actions that otherwise would not occur and that could have effects on listed, proposed, or candidate species. In fact, in the case of the Narita Levee repair, a segment of a golf course and a recreational trail was relocated landward of the existing facility to provide space for the facility to be resloped landward of the existing levee configuration. In the case of the Pipeline Revetment, portions of a recreational trail and existing R/D pond were relocated landward of the existing facility in order to provide space for the facility to be resloped landward of the existing levee configuration. In the case of the Desimone Levee repair, a building that had been previously designed and permitted (but not yet constructed) was redesigned and reduced in scale and a 900 foot segment of an existing recreational trail were relocated to provide space for the facility to be resloped landward from the existing levee configuration. If anything, these interrelated effects on chinook and coho salmon, bull trout and bald eagles will be positive rather than deleterious.

10.6 Interrelated Effects

Interrelated effects are part of a larger action and depend on the larger action for their justification. [CFR §402.02] These proposed projects will not result in additional actions or conditions that could have adverse effects on listed, proposed, or candidate species. For this reason no interrelated effects are foreseen for chinook and coho salmon, bull trout and bald eagles.

10.7 Beneficial Effects

By themselves, these proposed projects and maintenance actions are not capable of returning the lower Green River to the PFCs embedded in the environmental pathways and indicators matrix. At the same time, the projects do not further degrade the river system, and do as much as is reasonably possible at each site to address historic degradation, as reflected in the pathways and indicators narrative. Over the long term, these projects will:

- Modestly increase overall bank stability in the system, thereby decreasing erosion and bank slumping that contribute to water quality degradation.
- Modestly increase the mean size, frequency and complexity of LWD in the lower Green River. In a practical sense, except for these projects there is at present no source for restoration of LWD levels within the action area reach of the river other than projects such as these since virtually no mature trees currently exist on these sites.
- Modestly increase the amount of sediment depositional areas and flood refuge habitats available to salmonids at higher flow events, outside the immediate channel in setback bench locations at the Desimone, Narita and Pipeline Levees; and, in the case of the Fenster Revetment, in Pautzke Slough.
- Modestly increase the amount, variety, and availability of cover and velocity refuge available for salmonids over a range of discharges, both along the channel margins and on the excavated benches at three of these project sites (Desimone, Narita and Pipeline).
- Modestly increase the type, amount, areal extent, and variety of native riparian vegetation through replacement of existing stands of invasive exotic, non-native species such as blackberries and reed canarygrass.
- Modestly increase the amounts of overhanging vegetative cover, allochthonous inputs, nutrient uptake and denitrification, terrestrial insect production, and LWD recruitment sources, due to plantings of native vegetation above the OHWM along the length of these project sites.

- Modestly improve salmonid upstream and downstream migration habitat, as well as rearing and flood refuge habitat. Based on assessments of fish utilization of a variety of natural and man-altered habitat types conducted by the USFWS (Peters et al. 1998) and the Skagit Cooperative (Beamer and Henderson 1998), it is reasonable to expect that listed, proposed and candidate salmonids will experience a net benefit due to completion of these projects.

11 CONSERVATION MEASURES

Conservation measures associated with this proposal include mitigation work that will reduce or eliminate potential adverse project impacts, create long-term improvements in fish and wildlife habitat, and evaluate both individual features and overall project success.

11.1 Mitigation Measures

Mitigation can be defined as:

- Avoiding impacts by not taking a certain action;
- Minimizing impacts by limiting the degree or magnitude of the actions by using appropriate technology or by taking affirmative steps to avoid or reduce the impact;
- Rectifying or eliminating the impact over time by preservation or maintenance operations during the life of the proposal;
- Compensating for the impact by replacing, enhancing or providing substitute sensitive areas or environments.
- Monitoring project impact and taking appropriate corrective measures.

11.2 Alternatives Considered

A cardinal principle of mitigation is the avoidance and minimization of adverse environmental impacts to the maximum extent practicable. The following discussion describes the alternatives considered by King County Rivers Section staff to the seven proposed project designs presented in this BA. In most cases, less damaging alternatives to existing levee and revetment configurations within the GRFCZD reach of the Green River are extremely limited due to serious public health and safety concerns posed by flooding, and severe existing land use constraints (i.e., the high cost of acquiring and removing and/or relocating existing adjacent public infrastructure such as trails, roadways and bridges, and commercial and high density residential properties) that preclude the incorporation of greater habitat benefits into these project designs. Nonetheless, King County Flood Hazard Reduction Plan (FHRP; King County 1993) policies encourage pursuit of such alternatives whenever possible.

Each of these proposed projects has therefore been designed to improve salmonid habitat and water quality functions to the maximum extent practicable within the existing rights-of-way and budgetary constraints. The primary method used will be slope reconfigurations, improvement of instream habitat, and in the case of the Fenster Revetment Repair, partial removal of a flood control facility. While construction of these projects in accordance with the designs presented herein will not result in full restoration of ecological functions and processes at these sites, they will not preclude future, more robust, habitat restoration initiatives. The realization of such initiatives will be dependent upon the identification of better solutions to the current habitat degradation problems posed by these facilities and the funding availability to acquire needed land rights for expanding the riparian corridor.

In accordance with criteria set forth in the FHRP, consideration was given to whether each of these seven facilities has at present a sufficient public purpose to justify its continued repair and maintenance. This analysis considered public health and safety with respect to flood containment, and the utility and serviceability of public infrastructure such as roadways and recreational trails. A range of alternative approaches was considered, including facility abandonment (i.e., allowing a facility to remain in place without repairs), total facility removal, facility setback and repair *in situ*. Results of this analysis for each of the sites are as follows:

Facility Abandonment (No Action)

Segale Levee: Facility abandonment would likely result in ongoing future damages and deterioration leading to eventual failure and resulting in impacts essentially identical to those discussed under facility removal above. In addition this alternative is inconsistent with FHRP policies. Therefore, abandonment/no action was deemed unfeasible.

Desimone Levee: Facility abandonment would likely result in ongoing future damages and deterioration, leading to eventual failure and resulting in impacts essentially identical to those discussed under facility removal above. In addition this alternative is inconsistent with FHRP policies. Therefore, abandonment/no action was deemed unfeasible.

Boeing Revetment: Facility abandonment would likely result in ongoing future damages and deterioration, leading to eventual failure and resulting in impacts essentially identical to those discussed under facility removal above. In addition this alternative is inconsistent with FHRP policies. Therefore, abandonment/no action was deemed unfeasible.

Frager Road Revetment: Facility abandonment would likely result in ongoing future damages and deterioration, leading to eventual failure and resulting in impacts essentially identical to those discussed under facility removal above. In addition this alternative is inconsistent with FHRP policies. Therefore, abandonment/no action was deemed unfeasible.

Narita Levee: Facility abandonment would likely result in ongoing future damages and deterioration, leading to eventual failure and resulting in impacts essentially identical to those discussed under facility removal above. In addition this alternative is inconsistent with FHRP policies. Therefore, abandonment/no action was deemed unfeasible.

Pipeline Revetment/Levee: Facility abandonment would likely result in ongoing future damages and deterioration, leading to eventual failure and resulting in impacts essentially identical to those discussed under facility removal above. In addition this alternative is inconsistent with FHRP policies. Therefore, abandonment/no action was deemed unfeasible.

Fenster Revetment: Because a decision was reached to remove the culverted portion of the Fenster Revetment blocking the outlet to Pautzke Slough it was not necessary to consider abandonment of this portion of the facility.

Facility Removal

Segale Levee: Removal of the Segale Levee would flood all of Southcenter and environs, extending from the southern Tukwila city limits to I-405. Severe flooding would range from a few feet to over six feet deep and would likely result in extensive loss of life and hundreds of millions of dollars of damage to public infrastructure and private commercial property. Therefore, removal was deemed unfeasible.

Desimone Levee: Removal of the Desimone Levee would flood an extensive portion of the business district that occupies the eastern Green River valley near and downstream from S. 180th St., extending from the southern Tukwila city limits to I-405. Severe flooding would range from a few feet to over six feet deep and would likely result in extensive loss of life and hundreds of millions of dollars of damage to public infrastructure and private commercial property. Therefore, removal was deemed unfeasible.

Boeing Revetment: Removal of the Boeing Revetment would likely result in loss of public right of way and trail usage along South Russell Road. Maintenance of such public usage is stated as a priority in FHRP policies dealing with prioritization of flood damage repairs. Road failure could also lead to overbank flooding during extreme flood events affecting the Boeing Aerospace Center and environs east of So. Russell Road and north of So. 212th St. Therefore, removal of the Boeing Revetment was considered inconsistent with FHRP policies and not pursued.

Frager Road Revetment: Removal of the Frager Revetment would likely result in loss of public right of way and trail usage along Frager Road. Maintenance of such public usage is stated as a priority in FHRP policies dealing with prioritization of flood damage repairs. Road failure could also lead to overbank flooding during extreme flood events affecting the private farmlands and high density residential property currently being developed west of So. Frager Road and south of So. 212th St. Therefore, removal of the Frager Revetment was considered inconsistent with FHRP policies and not pursued.

Narita Levee: Removal of the Narita Levee would flood the City of Kent's Riverbend Golf Course and environs, extending through downtown Kent and including high density commercial and residential development. Severe flooding would range from a few feet to over six feet deep and would likely result in extensive loss of life and hundreds of millions of dollars of damage to public infrastructure and private commercial and multi-family residential property and public schools. Therefore, removal was deemed unfeasible.

Pipeline Revetment/Levee: Removal of the Pipeline Revetment/Levee would flood much the same area as described for the Narita Levee above, and would also flood several additional multifamily residential areas, public schools and a U.S. Post Office. Severe flooding would range from a few feet to over six feet deep and would likely result in extensive loss of life and hundreds of millions of dollars of damage to public infrastructure and private commercial and multi-family residential property and public schools. Therefore, removal was deemed unfeasible.

Fenster Revetment: Removal of the affected portion of Fenster Revetment would not appreciably increase flooding in comparison with current conditions. The facility was originally constructed not to exceed the 100 year flood crest elevation and also has allowed for backwater flows into the Pautzke Slough at moderate to high river stages. In addition, removal of that portion of the revetment constructed on fill across the mouth of the Slough would not preclude implementation of an environmentally responsible trail realignment in conjunction with Auburn's future development of this site as a park and/or open space. Removal of the revetment and culvert currently draining the slough was therefore selected as the preferred alternative for this project.

Facility Setback

Segale Levee: Repeated attempts to acquire additional right of way along the Segale Levee have proved to be futile because of a refusal by the landowner to grant or negotiate an adequate easement. Therefore, facility setback is not feasible at this site.

Desimone Levee: The proposed project design reflects the maximum setback easements that could be obtained from the landowners consistent with continued use of these high developed commercial warehouse and light manufacturing properties. During development of a vacant parcel in 1997 and 1998, King County Rivers Section staff conducted extensive negotiations with the landowner and the City of Tukwila to obtain an easement that allowed the levee to be set back up to 30 feet in 1998. Additional segments of the facility were set back in 1999. Additional setbacks are not effectively precluded by buildings and parking lots that have already been reduced from their originally designed and/or constructed footprints.

Boeing Revetment: Prior to 2000, setback of this facility is constrained by the presence of S. Russell Road at the top of the facility slope. In 1999 Rivers Section staff entered discussions with City of Kent staff regarding the subdivision of vacant commercial land east of Russell Road landward of this facility. As a result of permit conditions for the subdivision, the Boeing Company dedicated a 200-foot right-of-way corridor to the City of Kent to allow for removal of Russell Road and relocation of the Boeing Levee 200-feet landward of the top of bank. The current project is being pursued to stabilize a slump that is contributing high sediment loads to the river during winter storms, and to bench back and revegetated the unstable slope and introduce LWD into the river, pursuant to the levee relocation project.

Frager Road Revetment: In 1998 Rivers Section staff attempted to reallocate FEMA flood damage repair cost-share monies from the repair of a set of flood damaged facilities deemed not to serve a sufficient public purpose to justify continued repair and maintenance to the purchase of floodprone properties and/or strips of riparian land adjacent to facilities that could be set back from their current location along the lower Green River in Kent. As part of this exercise, we approached all the landowners along Frager Road from RM 18.4 to 19.1 to explore their interest in selling easements for this purpose. None of these landowners were interested in this acquisition proposal. Therefore, setback of this damaged portion of the Frager Road Revetment is not feasible, and an *in situ* repair is proposed instead.

Narita Levee: Setback of this facility is constrained by the presence of the Riverbend Golf Course at the top of the facility slope. In 1998, Rivers Section staff entered discussions with the landowner, the City of Kent Parks Department, that culminated in an agreement to allow reconfiguration of a strip of the golf course play zone and the Green River trail landward of this facility. The current project design reflects the maximum set back that could be achieved given the land use and infrastructure constraints at this site.

Pipeline Revetment/Levee: Setback of this facility is constrained by the presence of the Riverwood Apartments and an existing R/D pond landward of the facility. In 1996, Rivers Section staff entered discussions with the owner of the apartment complex; the City of Kent Department Public Works, which established the requirements for the R/D pond; and the City of Kent Parks Department, which is responsible for a segment of the Green River trail that lies at the top of the revetment/levee bank, that in 1998 culminated in an agreement to allow reconfiguration of the trail, the R/D pond and some of the apartment complex landscaping in order to set back this facility. The current project design reflects the maximum set back that could be achieved given these land use and infrastructure constraints at this site.

Fenster Revetment: As discussed above, removal of the damaged culvert would provide greater habitat benefits and therefore is proposed instead of a setback of this facility segment.

In Situ Repair

Segale Levee Repair: Since the 1996 *in situ* repairs shown in Figure 3.2 were conducted toe rock has become dislocated in patches over approximately 175 lineal feet of this earlier repair, due to shifting of the sandy river bed and undercutting erosion. Because lower and middle bank zones above the missing toe rock are thoroughly revegetated with willow layers that could be lost if undercutting proceeds further, a decision was made to restore the toe in a manner that provides substantially greater volumes of LWD while avoiding wholesale disturbance of the willows and upper bank.

Desimone Levee Repair: As discussed above, setback of the damaged facility would provide greater habitat benefits and therefore is being pursued instead of *in situ* repair of this flood damaged facility segment.

Boeing Revetment Repair: As discussed above, there are land use and infrastructure constraints to the removal or setback of this facility. Therefore, *in situ* repair is proposed instead. The repair will, however, attempt to maximize instream habitat benefits in the form of LWD embedded within and placed parallel to the facility toe which will provide a modest amount of cover and hydraulic refuge for salmonids. The project will also maximize riparian habitat benefits by sloping back the bank and revegetating it native riparian trees and shrubs.

Frager Road Revetment Repair: As discussed above, there are land use and infrastructure constraints to the removal or setback of this facility. Therefore, in situ repair is proposed instead. The repair will, however, attempt to maximize habitat features in the form of LWD added to the existing eddy pool adjacent to the toe of the facility, and a series of sturdy hemicylindrical culvert segments interspersed with coniferous logs rootwads embedded into the toe to provide a modest amount of cover and hydraulic refuge for salmonids.

Narita Levee Repair: As discussed above, setback of the damaged facility would provide greater habitat benefits and therefore is being pursued instead of in situ repair of this flood damaged facility segment.

Pipeline Revetment/Levee Repair: As discussed above, setback of the damaged facility would provide greater habitat benefits and therefore is being pursued instead of in situ repair of this flood damaged facility segment.

Fenster Revetment Repair: As discussed above, removal of the damaged culvert would provide greater habitat benefits and therefore is being pursued instead of in situ repair of the culvert.

11.3 Construction Mitigation Measures

Construction mitigation includes a combination of physical measures, real-time monitoring, sound project management procedures. The following sequence of events will be used at all project sites to ensure that both riparian and in-stream impacts are minimized or eliminated.

1. A pre-construction meeting will be held with the project team, permit agencies, tribal representatives and construction crews to ensure that mitigation measures are understood and agreed upon.
2. Clearing and construction limits will be staked and flagged. During the construction period no disturbance beyond the clearing/construction limits will occur.
3. Filter fabric fencing will be installed along topographic contours to prevent sediment and debris from entering the water.
4. All erosion control will be maintained in accordance with King County standards and manufacturer's recommendations and will be inspected daily by workers trained in the proper application of erosion and sediment control measures.
5. Levee slope faces will be brought as close as possible to final grade and mulched with straw as needed during any anticipated periods of rainy whether.
6. All areas that reach final grade will be hydroseeded within seven days.
7. To minimize construction impacts to fish resources, all instream work will be confined to the construction window(s) established by WDFW and/or federal agencies.
8. Rivers Staff will coordinate with the HHD flow management to avoid release of freshets during time of in-water work.
9. Turbidity will be daily monitored using a portable turbidity meter to ensure that background water quality is maintained downstream from the WDOE-established 250 foot dilution zone.
10. In order to sequester any observed plumes of silt entering the water from the construction area, a floating turbidity curtain (see Figure 10.1) will be deployed prior to construction below the OHWM and left in place for the duration of inwater construction activities.
11. An undisturbed band of existing vegetation will be left intact along the waterline until excavation of LWD anchor trenches.
12. Initial clearing will leave the soil duff layer and root structure intact prior to full site excavation.
13. A qualified ecologist, or appropriately trained staff working under the direction of the ecologist, will be on-site to monitor salmonid activity to assess fish behavior during construction. If construction activities are observed to affect salmonid migration and/or spawning behavior, the ecologist will arrange for work to be stopped immediately until the situation is resolved. Construction will be halted between late afternoon and early morning plus all day Sunday to allow uninterrupted salmonid migration during these periods.
14. Log trench excavation will start at the upstream end of the project and proceed downstream so that successive log installation can proceed in the hydraulic shadow of logs already installed

upstream. An earthen "plug" will be left intact at the riverward end of each trench until the moment of actual log insertion in order to minimize turbidity. In the event that saturated soils are encountered during excavation, these areas will be sequestered within undisturbed soil areas, or with gravel filtration berms, overexcavated and backfilled with clean crushed rock and gravels to form a seepage filter. Excavated materials will be exported immediately or stockpiled well away from the river bank so that loose material cannot slough back into the river and contribute to downstream turbidity.

Tables 11.1 through 11.3 summarize construction monitoring activities and water quality standards that will be used to determine compliance

Table 11.1 Summary of Construction Monitoring Activities

Construction Monitoring Activity/ Response	Frequency	Timing
Photodocumentation	Daily	As needed to document implementation and effectiveness of TESC practices including the turbidity curtain.
Water Quality Monitoring	Daily	During inwater construction.
Fish Use and Behavior	Daily	During inwater construction.

Table 11.2 Water Quality Monitoring Sampling Stations.

Station	Location
SS-1	50 feet upstream from the project site to establish background levels.
SS-2	Landward side of downstream end of turbidity curtain.
SS-3	Waterward side of downstream end of turbidity curtain.
SS-4	250 feet downstream from turbidity curtain.
SS-5	One-quarter mile downstream from the turbidity curtain.

Table 11.3 Water Quality Monitoring Criterion[1].

Parameter	Threshold
Turbidity	≤5 NTUs/background when background is ≤50 NTUs, or ≤10% increase when background is > 50 NTUs

[1] Criteria for these parameters for Class A waterbodies are set forth in Chapter 73-201A WAC.

11.4 Long-Term Mitigation Goals and Performance Monitoring

The long-term **mitigation goals** of these projects include:

1. Stabilization of eroding riverbanks using bioengineering techniques,
2. Improvement of instream and riparian habitat for ESA-listed species and,
3. At the Fenster Revetment Repair site only, restoration of juvenile access to an existing off-channel slough.

Each of the long-term mitigation goals described above include specific measurable objectives that will be used to determine the degree to which mitigation goals are being achieved. This section describes these objectives and their associated performance standards, monitoring methods and maintenance/contingency measures.

Objective 1: Stabilize eroding riverbanks using bioengineering techniques.

Performance Standards
- Eliminate existing bank failures including slides, slumps and surface erosion
- Prevent future bank failures and erosion problems

Monitoring Methods
- Each project site will be inspected for signs of bank failure and surface erosion both during and after major rainfall events and large floods. Monitoring associated with major rainfall will continue until vegetation is well established and the risk of surface erosion has become negligible. Flood related monitoring will continue through the life of the proposal.
- In addition to the storm- and flood-driven inspections, riverbank stability will be documented using photographs taken annually from fixed photopoints during the summer and winter.

Maintenance and Contingency Measures
- In the event that small areas within the repaired and/or resloped bank are not stable (e.g., minor slumps or rills are present) repairs will be made as needed using hand labor to apply coir fabric, straw, grass seed or other appropriate materials. In the event that large areas within the project are not stable, the project team will analyze the problem and develop a proposal to eliminate bank instability using appropriate bioengineering techniques.

Objective 2a: Provide instream cover and hydraulic refuge using complex arrays of LWD as shown in the project design plans.

Performance Standards
- LWD will be installed in a manner that provides an increase in cover below the ordinary high water mark.
- LWD will be installed in a manner that provides an increase in hydraulic refuge in each project site.
- No less than 90 percent of the installed LWD will continue to provide instream fish habitat throughout the five year monitoring period.

Monitoring Methods
- A preconstruction survey will be done at each project site to document the quantity and function of any exiting LWD and other features that may provide cover or hydraulic refuge.
- After construction, each piece of LWD will be tagged and mapped using global positioning system (GPS) equipment to document its location, orientation and the area of cover and/or hydraulic refuge it provides.
- Photopoints will be established and photos will be taken at each photopoint annually during the summer and winter to document the presence or absence of installed and recruited LWD and qualitatively document the hydraulic function of these elements.
- LWD installations will be inspected during late summer or early fall. Misaligned, damaged, or missing pieces, as well as recruited woody debris, will be noted.
- LWD performance during floods will be assessed qualitatively by inspections during and after large floods (≥ 9,000 cfs).

- If photodocumentation or routine site inspections suggest significant adverse changes in the LWD position, condition or function, post construction GPS-mapping will be repeated as needed to provide quantitative data on the nature and effect of these changes.

Maintenance and Contingency Measures

- All LWD installations will be maintained annually through year five by repositioning misaligned pieces (i.e., those that are lost or are flung on the middle or upper banks during floods), inspecting and repairing anchoring systems, and/or replacing missing pieces as needed to meet performance standards.

Objective 2b: Create instream cover by establishing overhanging native vegetation (mostly willows) along the lower bankline, immediately above the ordinary high water mark.

Performance Standards

- Project plantings along the lower bank will exhibit ≥80 percent cover by year five.
- Project plantings along the lower bank will result in a net increase in the area of vegetation overhanging the river at the ordinary high water mark.
- Project plantings along the lower bank will result in a net increase in the relative percentage of cover provided by native species.

Monitoring Methods

- Prior to construction the existing overhanging vegetation will be surveyed to assess the extent of cover at the ordinary high water mark, and the species composition of the vegetation providing this cover.
- Photopoints will be established and photos will be taken at each photopoint annually during the summer (May-June) to qualitatively document overhanging cover along the bankline.
- If, at the end of year five, results of the photodocumentation are not conclusive, the pre-construction survey will be repeated to provide quantitative data on the net effect of the project on the extent and nature of the cover provided by bankline vegetation.

Maintenance and Contingency Measures

- In the event that willows exhibit less than 80 percent cover by year five, additional live willow stakes will be installed during the fall to attain these performance standards. It should be noted that willow replacement may not be possible during the winter due to high river stages.

Objective 2c: Establish a native riparian plant community above the ordinary high water mark.

Performance Standards

- All planted species above the willow geogrid layers will demonstrate ≥90 percent survival by year one and ≥80 percent survival by year three.
- Native plants less than one meter in height along transects will exhibit >60 percent survival by year three and ≥80 percent coverage by year five.
- Native plants between three and six feet in height along transects will exhibit shrub or sapling cover of ≥50 percent by year five.

- Non-native and other invasive species (blackberries, knotweed, reed canarygrass Scot's broom, English ivy, morning glory, butterfly bush, etc.) along transects will compose <10 percent cover in any given stratum.

Monitoring Methods
- Photopoints will be established and photos will be taken at each photopoint annually during the summer and winter to qualitatively assess native riparian plant community conditions.
- Success at establishment of native riparian plant communities will be quantitatively evaluated on a percent survival and percent cover basis in years one, three and five.

Maintenance and Contingency Measures
- Invasive, non-native species will be removed annually through year five.
- In the event that native tree and shrub survival and growth does not meet the performance standards, an assessment of the cause of the poor survival and/or growth will be made and additional plants will be installed during the winter months. Installation and maintenance procedures will be adjusted as needed to improve vegetation growth and vigor.

Objective 2d: Provide a net improvement in instream habitat for ESA-listed species.

Performance Standard
- Increase the actual fish use of the project sites over that of nearby control sites with characteristics similar to those of each of the project sites prior to construction.
- Provide fish use and behavior information that can be used by watershed managers to better understand the relative benefits of different recovery strategies in the lower Green River.

Note: Objectives 2a through 2c are based on widely held belief that LWD and overhanging vegetation are beneficial to fish populations (Peters et al, 1998; Beamer and Henderson, 1998). Objective 2d attempts to integrate these individual measures at the most fundamental level through the direct observation of fish behavior at a representative set of project sites (including sites previously repaired with the addition of LWD and native vegetation), and at associated control sites. However, the project proponents recognize that both environmental and institutional factors (e.g. changes in ocean conditions, fisheries regulations, or local field conditions) may limit the ability to draw definitive conclusions from the monitoring data collected in conjunction with this mitigation objective. Nonetheless, a good faith effort will be made to, at a minimum, help fill critical gaps in our regional understanding of fish activity in the lower Green River and of the appropriateness of mitigation efforts that have become permit requirements in recent years. The proponents of this proposal will actively support efforts to coordinate regional data collection and are prepared to modify the data collection activities that support objective 2 to help fill this regional need. The proponents are already coordinating with the U.S. Fish and Wildlife Service and with members of the WRIA 9 Technical Committee toward this end.

Monitoring Methods
- An assessment of juvenile salmonid activity along the shoreline at a representative set of project sites, and in nearby control reaches, will be used to evaluate the effectiveness of the habitat enhancement techniques proposed herein. The primary method used will be direct observation; however, other techniques may be required to overcome environmental constraints. Information on preliminary salmonid habitat use surveys is included in Chapter 2 of this document.

- Each year, between January and June during the chinook salmon out-migration, direct observations of juvenile fish abundance and behavior will be completed using the protocols established during the pre-construction assessment[1].

Contingency Measures
- If fish use at the monitored project sites is shown to decline relative to fish use at the control sites, the proponent will consult with regional experts (e.g. biologists at NMFS, USFWS, USACE, WDFW, the University of Washington and other universities) to determine whether additional mitigation would be effective at these sites, or whether greater benefit to fish would be accrued through contributions to future projects completed elsewhere in the Green River watershed.

Objective 3: Restore fish passage through the Fenster Revetment to allow juvenile fish passage into Pautzke Slough (Fenster Revetment Repair only).

Performance Standard
- Remove the existing fish passage obstruction and create a woody debris complex in order to facilitate movement of fish into the off-channel slough.

Monitoring Methods
- The portion of man-made levee breach and associated woody debris complex will be inspected annually for signs of erosion, sedimentation, displacement of woody debris and/or any other changes that may affect might adversely affect fish passage to the slough.
- Fish presence in a 100-foot segment of Pautzke Slough will be assessed during the first, third and fifth years following construction by direct observation and/or hand-netting and/or non-lethal angling for salmonid juveniles, whichever method proves most effective and for which an ESA Section 10 permit can be obtained. The presence of salmonids in this area, which is above the historic fish barrier, will indicate that fish passage has been successfully restored.

Contingency Measures
- In the event that juvenile salmonids are not observed upstream of the improved passage structure, the project team will analyze and, if feasible, correct facility characteristics that may be preventing upstream fish movement.

Table 11.4 summarizes the long-term monitoring activities to be conducted over a five year period, starting in the summer prior to construction and ending five years after final construction.

Table 11.4 Summary of Long Term Monitoring Activities

Long Term Monitoring Activity/ Response	Frequency	Timing
Baseline LWD and vegetation assessments	Once	Late spring or summer, prior to constructions.
Slope and LWD Stability Inspections	Annually and during storm and flood events	Late summer/early fall : August-October and Nov.-March, during and following each Phase 3 (≥9,000 cfs) flood.

1 This work will continue for up to five years or until such time that the value of the mitigation measures relative to pre-existing conditions is sufficiently well understood. It is important to note that high flows could prevent this work from being completed each year of the five year monitoring period.

Maintenance Needs Assessment • Watering • Invasive species control • Dead/missing plant replacement • Repair minor scours and slumps	Annually	Inspect in spring: March-May Water as needed in summer: July-September Control weeds in spring: March-September Replace plants in winter: November-February Year around as detected, depending on crew availability.
Photodocumentation	Annually	Summer: May-June Winter: December-January During Floods: November-March
Vegetation Assessment • Tree and shrub survival/cover • Willow survival/cover	Years 1, 3, 5	Late summer/early fall: August-October
Fish Passage Assessment (Pautzke Slough)	Years 1, 3, 5	Winter/early spring: December-April
Fish Use and Behavior Study (mainstem)	Annually	Spring: May-June
Monitoring Reports	Annually	Due December 31

11.5 Reporting

Monitoring reports will be provided to the permit agencies at the end of each calendar year and will include, at a minimum:

- A summary of the monitoring efforts and findings since project inception.
- A detailed report of the data collection and analyses, and maintenance and contingency measures, employed during the previous twelve months.
- Prognosis for the success of each mitigation element and each project as a whole.

In addition to providing specific information on the success of the conservation measures employed during the course of the projects included in this proposal, the data and findings produced should support future conservation efforts at several levels of watershed management. Information that will be included in the monitoring reports that will support the regional recovery efforts include:

- Recommendations on ways to improve bank stabilization best management practices both during and after construction.
- Information on what can reasonably be achieved with the proper application of mitigation measures.
- Fish use and behavior data that will help fill gaps in our understanding of how fish use the lower Green River.

In order to ensure that the findings from the monitoring elements of this conservation effort are put to best use, the project proponents will make the monitoring findings available to a wide audience through King County's web pages and through direct interaction with representatives of the WRIA 9 technical committee. If, during the course of the proposal, unified regional approach to project monitoring and/or fish-use assessments are developed the monitoring procedures and protocols associated with this proposal will be modified to the extent practicable to facilitate data sharing and improved management of the region's fisheries and riparian-zone resources.

12 DETERMINATION OF EFFECT

12.1 Bald Eagle

A determination of **May Affect, Is Not Likely to Adversely Affect** is made for bald eagles.

The projects **May Affect,** but **Are Not Likely to Adversely Affect** or modify bald eagle roosting or feeding habitat. The projects will have slightly **Beneficial** effects because they will create a narrow, but slightly more complex riparian corridor within the seven project sites. Over many decades, the projects will contribute to development of a narrow riparian buffer, including trees at all of the sites except the Segale Levee Repair site, including opportunities for green-top and snag establishment. These features will provide a small amount of potential bald eagle perching habitat, which is now limited in the action area. These projects will have **Discountable Effects** on bald eagle roosting or feeding behavior because six of the seven projects lack salmonid spawning habitat and thus are not sites where bald eagles would tend to forage. At the seventh site, construction will be completed well before the beginning of the salmonid spawning periods, before carcasses are present that could attract eagles.

12.2 Chinook Salmon

A determination of **May Affect, Likely to Adversely Affect** is made for chinook salmon.

The projects **May Affect,** and are **Likely to Adversely Affect** or modify chinook migration and rearing habitat. The projects will have adverse effects during construction because construction will occur during the tail end of juvenile downstream migration period, and within the beginning of the adult upstream migration period in six sites that do not contain spawning habitat. At the seventh site, construction will be completed before spawning begins, but juvenile and adult chinook salmon could be present. While some turbidity will be generated during construction, turbidity levels will not adversely affect spawning habitat at six of the seven sites, since spawning habitat is not present at those sites. Unquantifiable volumes of fine sediment particles at these six sites are expected to settle on riverbed areas already composed almost exclusively of sand and silt. At the Fenster Revetment Repair site, where patches of spawning habitat are present adjacent to and downstream from the site, unquantifiable volumes of fine sediment could be deposited on such gravels. Sedimentation impacts will be mitigated to the maximum extent practicable, but a minor degree of sedimentation is expected at all sites because (1) replacement of missing toe rock and installation of LWD within the toe of these facilities will occur below the OHWM in lower bank materials that are composed of fine-grained alluvium, (2) the turbidity curtain to be deployed in the water adjacent to facility toe areas during excavation will not sequester 100 percent of the silt released during construction activities, (3) and temporary cessation of construction will not fully prevent an increase in turbidity adjacent to and downstream from these sites during toe repair and LWD installation.

These projects will have **Beneficial** long term effects because the projects include both active and passive measures that will locally restore habitat-forming processes within the severe existing constraints imposed by existing land uses surrounding these sites. The active restorative measures include stabilization of eroding and slumping streambanks, control of nonpoint (e.g., e.g., from chronic erosion and episodic slumping) and point source pollutants (e.g., from construction machinery), and installation of LWD. The passive measures, including revegetation, will provide long-term shade, cover, LWD recruitment and litter inputs. Together, these will help restore the physical structure and water quality chemistry at these project sites, thus contributing to habitat forming processes that benefit salmonids, including chinook and coho salmon.

12.3 Bull Trout

A determination of **May Affect, Likely to Adversely Affect** is made for bull trout.

Utilization of the action area by bull trout during the has not been confirmed, and is considered unlikely because of high summer temperatures. However, if bull trout are present, the possible utilization of the project sites by bull trout will cause these fish to be adversely affected by the proposed projects for the same reasons noted above for chinook salmon.

12.4 Coho Salmon

An effect determination is not being made at this time for coho salmon, a candidate species. If proposed for listing, however, a determination of **May Affect, Likely to Adversely Affect** would be appropriate.

Utilization of the project sites by coho salmon will cause these fish to be adversely affected by the proposed projects for the same reasons noted above for chinook salmon.

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ACRONYMS

AKART	All known and reasonable techniques
BA	Biological assessment
BMP(s)	Best management practice(s)
CWA	Clean Water Act
dbh	Diameter at breast height
ESC	Erosion and sediment control
FEMA	Federal Emergency Management Agency
FODS	Factors of Decline Subcommittee
GRFCDZ	Green River Flood Control Zone District
HCP	Habitat Conservation Plan
HHD	Howard Hanson Dam
JFE	Jobs for the Environment
KC WLRD	King County Water and Land Resources Division
LWD	Large woody debris
NPF	Not properly functioning
OHWM	Ordinary high water mark
PFC(s)	Properly functioning condition(s)
PL	Public law
R/D	Retention/detention
RM	Rivermile
SPF	Standard project flood
SR	State route
SRH	Shaded riparian habitat area

SWD	Small woody debris
TESC	Temporary erosion and sediment control
TPU	Tacoma Public Utilities
USACE	United States Army Corps of Engineers
USFS	United States Forest Service
USFWS	United States Fish and Wildlife Service
UW	University of Washington
WCC	Washington Conservation Corps
WDF	Washington Department of Fisheries (a predecessor agency of WDFW)
WDFW	Washington Department of Fish and Wildlife
WRIA	Water Resource Inventory Area
WDW	Washington Department of Wildlife (a predecessor agency of WDFW)
WTP	Wastewater treatment plant
YOY	Young of the year

Appendix A: Green River Flood Control Zone District Facility Map

Appendix B: Background Information Reviewed for this Report

The following sources were reviewed for information on species presence and habitat and water quality conditions:

- Correspondence from the U.S. Fish and Wildlife Service (USFWS 1998) regarding federally listed, proposed and candidate species that may occur in the action area.
- Correspondence from National Marine Fisheries Service (NMFS 1998) regarding federally proposed threatened species that may occur in the action area.
- Washington State midwinter bald eagle survey results for 1989 (WDW 1989).

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Appendix C: Project Drawings

Appendix D: Project Photographs

Appendix C-B2. Desimone Levee Repair. Levee face prior to bench excavation.
Aspect = south (looking upstream); September, 1999.

Appendix C-B3. Desimone Levee Repair. Levee face prior to bench excavation.
Aspect = north (looking downstream); September, 1999.

Appendix C-B4. Desimone Levee Repair. Levee crest prior to bench creation. Aspect = south (looking upstream); September, 1999.

Figure C-B5. Desimone Levee Repair. Levee backslope vegetation planted during 1998-1999 plant dormancy season. Aspect = north; September, 1999.

Appendix C-A2. Segale Levee Repair. Willows and LWD installed during the 1996 repair project (just upstream from 2000 project). Aspect = southwest; July, 1999.

Appendix C-A3. Segale Levee Repair. Missing toe rock to be replaced with addition of LWD in 2000. Aspect = west; October, 1997.

Appendix C-C2. Boeing Revetment Repair. Toe rock and logs installed during 1996 repair (just upstream from present repair). Aspect = southwest; June, 1996.

Appendix C-C3. Boeing Revetment Repair. Slump at 2000 repair site. Aspect = east; September, 1999.

Appendix C-D2. Frager Road Revetment Repair. Lateral scour pool beneath slump. Aspect = northwest (looking downstream); September, 1999.

Appendix C-D3. Frager Road Revetment Repair. Slump at 2000 repair site. Aspect = west; September, 1999.

Appendix C-E2. Narita Levee Repair. Mid-slope bench excavated in April, 1999. Aspect = north (looking downstream); July, 1999.

Appendix C-E3. Narita Levee Repair. City of Kent's Riverbend Golf Course adjacent to levee backslope. Aspect = east; July, 1999.

Appendix C-F2. Pipeline Levee Repair. Levee face following 1999 low bench excavation. Aspect = south (looking downstream); August, 1999.

Appendix C-F3. Pipeline Levee Repair. Trees relocated from Pipeline to Okimoto Revetment just upstream. Aspect = south (looking downstream); August, 1999.

Appendix C-F4. Pipeline Levee Repair. Levee face following 1999 low bench excavation. Aspect = north (looking upstream); August, 1999.

Appendix C-F5. Pipeline Levee Repair. Levee backslope following 1999 low bench excavation. Aspect = north (looking upstream); August, 1999.

Appendix C-G2. Fenster Revetment Repair. Revetment face. Aspect = west (looking downstream); July, 1999.

Appendix C-G3. Fenster Revetment Repair. Revetment crest. Aspect = west (looking downstream); July, 1999.

Appendix C-G4. Fenster Revetment Repair. Field in developed City of Auburn park adjacent to revetment crest. Aspect = southwest (looking downstream); July, 1999.

Appendix C-G5. Fenster Revetment Repair. Project Manager and temporary field assistants. Aspect = northwest (looking downstream); July, 1999.

Appendix E: Habitat Characterization and Fish Habitat Utilization Monitoring Forms

Green River /King County Habitat Data Sheet

Date 10/18 Weather Clear Page __ Of __ Crew (circle snorkelers) ______

Site Name [illegible] Reach Length 60m Bankfull Width ______ Discharge 386

HABITAT DATA Range Finder # ______

Ref No	Habitat Type 1	2	3	4	5	Bank	Temp °C	Ave Ln (m)	Ave. Wd (m)	Ave. Flow (ft/s)	Depth (m) Ave	Depth (m) Max	Bank angle rs	Bank angle rn	% Rip cover	Veg. Overh	LN UC Bank (m)	Cover Type	LN (m)	WD (m)	Comp	Substrate DM	SD	SZ	EM
SU	MC	SW	SD	LK	LT	L		60	3	–	1.0	–			0	0	0	Bld	60	2	m	2	1	1	1
																		LWD	2	2					
																		LWD	2	1					

Cedar River Chinook Habitat Use Snorkeling/Seining Data Sheet

e 10/1[illegible]/99 Weather Clear Crew (circle snorkelers) Bm ES LO Page__Of__

ch Name Segal Reach Code _______ Sampling Period (Day/Night) ____________

ID #	Level 1	Level 2	Level 3	Level 4	Level 5	DS Bank	set/ snorkel number	Chinook < 50 mm	Chinook > 50 mm	Coho Fry	Coho Smolt	0-age trout	Trout 50-100	Trout 100-200	ctt 200+	Sculpin	white fish
511	MC	SOOOW	SP	LT	LT		B	0									
[redacted]							E	0									
							L	0									
[redacted]																	
[redacted]																	
[redacted]																	
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[redacted]																	
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[redacted]																	

Green River /King County Habitat Data Sheet

Date ~~Desimoni~~ 10/18 Weather Clear Page__Of__Crew (circle snorkelers)

Site Name Desimini Reach Length 2 Bankfull Width 29 Discharge 386

HABITAT DATA **Range Finder #**

Ref No	Habitat Type 1	2	3	4	5	Bank	Temp °C	Ave Ln (m)	Ave. Wd (m)	Ave. Flow (ft/s)	Depth (m) Ave	Max	Bank angle rs	rn	% Rip cover	Veg. Overh	LN UC Bank (m)	Cover Type	LN (m)	WD (m)	Comp	Substrate DM	SD	SZ	EM
		[illegible]	[illegible]	[illegible]	GT	R		40	2	.12	1.0	.8	1.0	1.4	0	5%	0	Bld	40	2	m	7	6	6	[illegible]

Green River/King County Habitat Use Snorkeling/Seining Data Sheet

Date 10/18 Weather clear Crew (circle snorkelers) BM CARS Page __ Of __

Reach Name Desmoni Reach Code ______ Sampling Period (Day/Night) ______

Hab Ref #	Level 1	Level 2	Level 3	Level 4	Level 5	DS Bank	set/ snorkel number	Chinook < 50 mm	Chinook > 50 mm	Coho Fry	Coho Smolt	0-age trout	Trout 50-100	Trout 100-200	ctt 200+	Sculpin	white fish
D1	MC	SWPW	SP	LT	LT	R	B	0	-	-	-	-	-	-	-	-	-
[redacted]							L	0	-	-	-	-	-	-	-	-	-
							2	0	-	-	-	-	-	-	-	-	-
[redacted]																	
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Green River /King County Habitat Data Sheet

Date 10/18/99 Weather Clear Page__Of__Crew (circle snorkelers)______

Site Name Segal / Hosmani ~~Queen~~ Boring Control Reach Length 37~~40~~ Bankfull Width 19 Discharge 386

HABITAT DATA

Range Finder #______

Ref No	Habitat Type 1	2	3	4	5	Bank	Temp °C	Ave Ln (m)	Ave. Wd (m)	Ave. Flow (ft/s)	Depth (m) Ave	Max	Bank angle rs	rn	% Rip cover	Veg. Overh	LN UC Bank (m)	Cover Type	LN (m)	WD (m)	Comp	Substrate DM	SD	SZ	EM
588[illegible]	MC	SwDw	SO	LT	LT	~~R~~		~~40~~	~~2~~																
[redacted]						R		~~40~~ 37	2		.65	1.4	1.3	1.8	~~0~~	~~4~~	~~0~~	~~Bld~~	~~40~~	~~2~~	~~S~~	5	4	4	~~2~~
															0	0	0	Bldr	40	2	S	6	4	4	2
[redacted]																									

10/18/99 SEGALE/DESIMONE CONTROL Conx/q

Hab Ref #	Level 1	Level 2	Level 3	Level 4	Level 5	DS Bank	set/ snorkel number	Chinook < 50 mm	Chinook > 50 mm	Coho Fry	Coho Smolt	0-age trout	Trout 50-100	Trout 100-200	ctt 200+	Sculpin	white fish
52B.1	MC	SWDW	SP	CT	CT		L/[illegible]	0	—	—	—	—	—	—	—	—	→
[redacted]							R	0	—	—		—			—	—	→
							B	0									
[redacted]																	
[redacted]																	
[redacted]																	
[redacted]																	
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[redacted]																	
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Green River /King County Habitat Data Sheet

Date 10/4 Weather Cloudy Page__Of__Crew (circle snorkelers)____

Site Name Boeing Reach Length ~30 Bankfull Width 22 Discharge)

HABITAT DATA **Range Finder #**____

Secc 2m

Ref No	Habitat Type 1	2	3	4	5	Bank	Temp °C	Ave Ln (m)	Ave. Wd (m)	Ave. Flow (ft/s)	Depth (m) Ave	Max	Bank angle rs	m	% Rip cover	Veg. Overh	LN UC Bank (m)	Cover Type	LN (m)	WD (m)	Comp	Substrate DM	SD	SZ	EM
B[illegible]	MC	Slow	SP	[illegible]	CT	R		30	2	1.12	1.6	2.3	22	.5	Ø	90	1.Q	Veg	30	.5	M	2	[illegible]	[illegible]	[illegible]
[redacted]																									
[redacted]																									
[redacted]																									
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[redacted]																									

Across from Boeing

Green River/King County Habitat Use Snorkeling/Seining Data Sheet

Date 10/18 Weather Clear Crew (circle snorkelers) ____________ Page __ Of __

Reach Name Boeing Reach Code ________ Sampling Period (Day/Night) Day

Hab Ref #	Level 1	Level 2	Level 3	Level 4	Level 5	DS Bank	set/ snorkel number	Chinook < 50 mm	Chinook > 50 mm	Coho Fry	Coho Smolt	0-age trout	Trout 50-100	Trout 100-200	ctt 200+	Sculpin	white fish
B	MC	SWAN	SP	LT	LT	R	B	0	—	—	—	—	—	—	—	—	—
[redacted]							L	0	—	—	—	—	—	—	—	—	—
							R	0	—	—	—	—	—	—	—	—	—
[redacted]																	
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/ 2

Green River /King County Habitat Data Sheet

Date 10-4-99 Weather Cloudy Page__Of__Crew (circle snorkelers)__________

Site Name Frager Road Reach Length 40 Bankfull Width 25 Discharge________

HABITAT DATA **Range Finder #**__________

Ref No	Habitat Type 1	2	3	4	5	Bank	Temp °C	Ave Ln (m)	Ave. Wd (m)	Ave. Flow (ft/s)	Depth (m) Ave	Depth (m) Max	Bank angle rs	Bank angle m	% Rip cover	Veg. Overh	LN UC Bank (m)	Cover Type	LN (m)	WD (m)	Comp	Substrate DM	SD	SZ	EM
[illegible]	MC	SW	SP	RN	BW	L		15	2.5	3m/1.5	0.8	1.4	1.3	3	0	15%	0	Veg	1	.3	M	2	1	1	[illegible]
2	[illegible]	[illegible]	SP	RN	DW	L		15	4	0	1.3	2.0	.75	3	0	50	0	BH	15	4	M	2	1	1	

Boat ramp

Green River/King County Habitat Use Snorkeling/Seining Data Sheet

Date 10/5/99 Weather pt Cldy Crew (circle snorkelers)________ Page__Of__

Reach Name Fracer Reach Code ______ Sampling Period (Day/Night) ______

Hab Ref #	Level 1	Level 2	Level 3	Level 4	Level 5	DS Bank	set/ snorkel number	Chinook < 50 mm	Chinook > 50 mm	Coho Fry	Coho Smolt	0-age trout	Trout 50-100	Trout 100-200	ctt 200+	Sculpin	white fish
[illegible]							B	0									
[redacted]							L	0									
							R	0									
[illegible]							B	[illegible]									
[redacted]							L	0									
							R	0									
[redacted]																	
[redacted]																	
[redacted]																	
[redacted]																	
[redacted]																	
[redacted]																	
[redacted]																	
[redacted]																	

Green River /King County Habitat Data Sheet

Date 10-5-99 Weather Cloudy Page__Of__Crew (circle snorkelers) BM CC RS

Site Name Maidon/Apple Farm central Reach Length 65 Bankfull Width______ Discharge______ Control

HABITAT DATA Range Finder #______

Ref No	Habitat Type 1	2	3	4	5	Bank	Temp °C	Ave Ln (m)	Ave. Wd (m)	Ave. Flow (ft/s)	Depth (m) Ave	Depth (m) Max	Bank angle rs	Bank angle m	% Rip cover	Veg. Overh	LN UC Bank (m)	Cover Type	LN (m) ~~51 65~~	WD (m)	Comp	Substrate DM	SD	SZ	EM
[illegible]	[illegible]	BW	SP	CT	LT	L		54	2	.5	1	2.3	1.3	1.4	10	0	0	RR	~~58~~	2	M	7	6	6	5
[redacted]																									
[illegible]	[illegible]	DW	SP	CT	BW			11	2	.3	1.0	2.3	1	1.4	.0	0	0	RR	11	2	M	7	6	6	5
[redacted]																									
[redacted]																									
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Green River/King County Habitat Use Snorkeling/Seining Data Sheet

Date 10-5-99 Weather Cloudy Crew (circle snorkelers) ______ Page __ Of __

Reach Name Naida/pipeline/Fraser Reach Code Control Sampling Period (Day/Night) ______

vis ~3m <

Hab Ref #	Level 1	Level 2	Level 3	Level 4	Level 5	DS Bank	set/ snorkel number	Chinook < 50 mm	Chinook > 50 mm	Coho Fry	Coho Smolt	0-age trout	Trout 50-100	Trout 100-200	ctt 200+	Sculpin	white fish
							L	0	—	—	—	—	—	—	—	—	—
[redacted]							B	0	—	—	—	—	—	—	—	—	—
							R	7()	—	—	—	—	—	—	—	—	—

Green River /King County Habitat Data Sheet

Date 10-4-99 Weather Clear Page__Of__Crew (circle snorkelers)________

Site Name Pipeline Reach Length 83 Bankfull Width 24 Discharge________

HABITAT DATA Range Finder #________

Ref No	Habitat Type 1	Habitat Type 2	Habitat Type 3	Habitat Type 4	Habitat Type 5	Bank	Temp °C	Ave Ln (m)	Ave. Wd (m)	Ave. Flow (ft/s)	Depth (m) Ave	Depth (m) Max	Bank angle rs	Bank angle m	% Rip cover	Veg. Overh	LN UC Bank (m)	Cover Type	LN (m)	WD (m)	Comp	Substrate DM	Substrate SD	Substrate SZ	Substrate EM
	MC	SW RW	SP	LT	LT	R	–	83	2	~.3 m/s	1.0	2.11	2.1	1.7	0	5%	0	CB*	83	2	m	7	6	6	5
	C	SCO RW	SP	LT	LT																				
	[illegible]	RW	SP	LT	Rip																				

Meter to russel, mark Right ON Russel side is behind apartment

* Probably riprap since cobbles are unlikely to be present in this part of the Green R.

Green River/King County Habitat Use Snorkeling/Seining Data Sheet

Date 10-5 Weather Cloudy Crew (circle snorkelers) BM LB RS Page__Of__

Reach Name Pipeline Reach Code ________ Sampling Period (Day/Night) Day

Hab Ref #	Level 1	Level 2	Level 3	Level 4	Level 5	DS Bank	set/ snorkel number	Chinook < 50 mm	Chinook > 50 mm	Coho Fry	Coho Smolt	0-age trout	Trout 50-100	Trout 100-200	ctt 200+	Sculpin	white fish
P21	MC	SW/W	SP	LT	LT	R	B	0									
[redacted]							L	0									
							R	0									
[redacted]																	
[redacted]																	
[redacted]																	
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G Ri Ki Cou Hab Da Shee

Date 9/29/99 Weather Clear Page __ Of __ Crew (circle snorkelers) — 1 2

Site Name Foster Control Reach Length 40 Bankfull Width 27 Discharge ~400

HABITAT DATA Range Finder # ______

Ref No	Habitat Type					Bank	Temp °C	Ave Ln (m)	Ave. Wd (m)	Ave. Flow (ft/s)	Depth (m)		Bank angle		% Rip cover	Veg. Overh	LN UC Bank (m)	Cover Type	LN (m)	WD (m)	Comp	Substrate			
	1	2	3	4	5						Ave	Max	rs	rn								DM	SD	SZ	EM
[redacted]	[redacted]	[redacted]	SP	LT	CI	L	-	14	2	1.83	.8	1.6	.8	1.6	10%	.5%	~~0~~	BL	14	2	M	8	6	6	4
[redacted]																						~~[illegible]~~	~~[illegible]~~	~~[illegible]~~	~~[illegible]~~
[redacted]	[redacted]	[redacted]	SO	LT	SW	L	–	26	2	0	1.5	2.2	1.5	1.3	20	40	~~0~~	BL	26	2	M	8	6	6	4
[redacted]																		BH	4	2	M				

1 4 3 2

KC-0001

Green River /King County Habitat Data Sheet

Date 9/29/99 Weather Clear Page __ Of __ Crew (circle snorkelers) BM KB LO RS

Site Name Fowler Reach Length 57 Bankfull Width 33 Discharge ~400

HABITAT DATA

Range Finder #

Ref No	Habitat Type 1	2	3	4	5	Bank	Temp °C	Ave Ln (m)	Ave. Wd (m)	Ave. Flow (ft/s)	Depth (m) Ave	Depth (m) Max	Bank angle rs	Bank angle m	% Rip cover	Veg. Overh	LN UC Bank (m)	Cover Type	LN (m)	WD (m)	Comp	Substrate DM	SD	SZ	EM
	MC	[illegible]	SP	LT	LT	L	–	23	2	.42	1.1	2.5	1.0	1.7	0	0	0	BL	23	2	m	7	6	6	4
			SP	[illegible]	BW	L	–	34	2	.55	1.2	3.0	1.0	1.5	30	0	0	BL	34	2	m	7	8	6	4
			SP	MO	MC	m																			
							OFF SITE																		
			SP	MC	DW	R																			

Cedar River Chinook Habitat Use Snorkeling/Seining Data Sheet

KC-0001

Date 9/29/99 Weather Clear Crew (circle snorkelers) BM LO KB Page__ Of __

Reach Name Foster Reach Code ______ Sampling Period (Day/Night) Day

Hab Ref #	Level 1	Level 2	Level 3	Level 4	Level 5	DS Bank	set/ snorkel number	Chinook < 50 mm	Chinook > 50 mm	Coho Fry	Coho Smolt	0-age trout	Trout 50-100	Trout 100-200	ctt 200+	Sculpin	white fish
F1	MC	SLOW	SP	LT	LT	L	B							13		1	
[redacted]							L							12			
							K										
[redacted]		SLOW	SP	LT	LT	L	B							1			
[redacted]							L							1		1	
							K								1		
[redacted]																	
[redacted]																	
							BOUNDED		F1					4		2	
[redacted]									F2					1	2	2	
[redacted]																	
[redacted]																	
[redacted]																	
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Cedar River Chinook Habitat Use Snorkeling/Seining Data Sheet

Date__________ Weather______________Crew (circle snorkelers)________________________ Page__Of ___

Reach Name __________________ Reach Code _______ Sampling Period (Day/Night) ______________

Hab Ref #	Level 1	Level 2	Level 3	Level 4	Level 5	DS Bank	set/ snorkel number	Chinook < 50 mm	Chinook > 50 mm	Coho Fry	Coho Smolt	0-age trout	Trout 50-100	Trout 100-200	ctt 200+	Sculpin	white fish

Cedar River Chinook Habitat Data Sheet

Date_______________ Weather____________________________ Page__Of ___Crew (circle snorkelers)____________________

Site Name ____________________Reach Length __________Bankfull Width_______Discharge________

HABITAT DATA **Range Finder #**_______________

Ref No	Habitat Type					Bank	Temp °C	Ave Ln (m)	Ave. Wd (m)	Ave. Flow (ft/s)	Depth (m)		Bank angle		% Rip cover	Veg. Overh	LN UC Bank (m)	Cover Type	LN (m)	WD (m)	Comp	Substrate			
	1	2	3	4	5						Ave	Max	rs	rn								DM	SD	SZ	EM

Bank Stabilization Catch Data Sheet

Date______________ Sampling Period (Day/Night) ________________________ Weather_________________________ Crew_________________________________Page__Of __

Reach________________Reach Code ________________

ref#	Set #	species	ln(mm)	ref#	Set #	species	ln(mm)	ref#	Set #	species	ln(mm)	ref#	Set #	species	ln(mm)

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June 26, 1995

TO: Files

FROM: Alan W. Johnson

RE: Snorkeling Results from four areas in the Green River near SW 43rd Street in Tukwila, Washington.

On June 6, 1995, I snorkeled four sections of the Green River in the area referenced above. The snorkeling was at the request of Andy Levesque, King County Surface Water Management (SWM). Access to the snorkeling sites was via a small boat and motor that was launched from levee.

At the time of this inventory, the flow was low to moderate (the water surface level was below the vegetation line). Water velocities along the bank were estimated to be 1.5 to 2.5 feet per second. Because the water was turbid with suspended organic material (algae), visibility was limited to approximately three feet. The weather was cool; the skies were cloudy and overcast.

In this portion of the river, the channel has been straightened with levees built on both sides for flood control. As a result, the channel has a very uniform, trapezoidal shape. The substrate is sand and small gravel with areas of clay along the toe of the levee. The bank vegetation consists primarily of reed canary grass (*Phalaris arundinacea*), Himalayan blackberries (*Rubus procerus*), and small willows (*Salix sp*) and cottonwood (*Populus trichocarpa*).

All four sections snorkeled this day were along the left bank (as facing downstream). Very few fish were observed in any of the four sections. The only fish observed were juvenile salmonids and sculpins (*Cottus sp*). Because of the low visibility, identification of fish difficult; the fish were believed to be juvenile chinook salmon (*Oncorhynchus tshawytscha*). No adult salmonids or larger fish of any species were observed. Because of limited number of fish present in this area on this particular day, I feel it is difficult to draw any substantial conclusions about habitat usage in these areas. I would suspect that this area currently acts mostly as a migration area for adult fish moving to and juvenile fish moving from upstream areas.

Memo to files: Green River Snorkel Results, Tuhwila, Wa. 6/29/95

All four sections are near SW 43rd Street. The first section snorkeled was 1000 feet in a proposed SWM project area (the Seagale Levee) located along the left bank, approximately one-half mile upstream of the bridge. The proposed project is to rebuild the face and toe of the levee in this area. The river bank from the waters edge drops nearly vertically for two to three feet. The habitat along this bank is very uniform with little diversity.

The second area snorkeled was the 700 feet immediately downstream of the proposed project area. The toe of this section of levee consists of a layer (several feet thick) of small riprap. There are small spaces between the riprap; the surface of the toe is relatively smooth, hydraulically efficient face. Several times as I moved by, pieces of riprap moved downslope when touched. The small riprap along this toe creates a very uniform habitat with little diversity.

The third reach was an approximate 500 foot section directly under the SW 43rd Street Bridge. The toe consists of large riprap embedded with several pieces of large woody debris. The spacing of woody debris appears such that each piece acts independently of the next. While the habitat is uniform, there are larger spaces and an irregular surface that provides some area of lower velocity along the face that could be used by small fish. Because of the limited number of fish present this day, this observation could not be confirmed.

The final section snorkeled was a 500 foot section downstream of bridge. The toe of the levee in this area consists of large riprap (two - three feet in diameter). There was no wood imbedded in this section. Similar to the reach upstream, the large riprap creates larger spaces and an irregular surface along the face that could be used by small fish. Again, because of the limited number of fish present, this could not be confirmed.